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Graseby 3200
In-line Pressure Syringe Pump

Technical Service **Manual**

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Introduction

This Technical Service Manual together with the Instruction Manual, contains all the information that is needed in order to maintain, repair and operate the Graseby 3200 pump. The contents of this Manual are intended to be read and used by suitably qualified personnel.

AC input power connecting socket/cable

The AC input power socket that connects to the rear of the pump has three connections (live, neutral and earth) provided by a 3-way power cable. As the casing is doubly insulated, the AC input connector situated on the pump only utilises two connections (live and neutral), there is no third earth pin. This method of AC input enables similar AC input sockets (if required) to that supplied by Smiths Medical to be used.

Warnings and cautions

Warnings tell you about dangerous conditions that could lead to death or serious injury to the user or patient that can occur if you do not obey all of the instructions in this manual.

WARNINGS

1. **WARNING: To avoid over- or under- infusion, always verify that the brand and size of the loaded syringe are the same as the brand and size displayed on the screen before starting an infusion. Failure to do so may result in an inaccurate delivery of medication, resulting in patient injury or death.**
2. **WARNING: To avoid incorrect or inappropriate configuration of the pump, the Configuration menu must only be selected by qualified persons or authorised personnel. Incorrect pump configuration could lead to inappropriate infusion resulting in patient injury or death.**
3. **WARNING: This equipment is not suitable for use in the presence of flammable anaesthetics, oxygen-enriched or explosive atmospheres. The use of the device in such atmospheres may lead to explosion or fire.**
4. **WARNING: To avoid possible malfunction of the pump, do *not* expose the pump to X- rays, gamma rays or ionizing radiation, or to the RF interference or strong electric/magnetic fields emitted (for example) by diathermy equipment or mobile telephones. If the pump is used in the presence of, or in combination with Magnetic Resonance Imaging (MRI) machines it must be protected from the magnetic field emitted by such equipment. Malfunction of the pump can cause incorrect infusion or loss of infusion resulting in patient injury or death.**
5. **WARNING: Operation of the pump outside the temperature limits defined in the specification may result in erroneous operation. Ensure that the temperature is within the specified limits. Failure to do so may result in patient injury or user injury.**
6. **WARNING: In order to ensure that the intended infusion is performed, data must be entered correctly. Likewise before confirming any displayed data the user should ensure that it is correct. Failure to do so may result in compromised function of the product, patient injury or user injury.**
7. **WARNING: Failure to respond promptly to an alarm may result in patient injury or death.**
8. **WARNING: Failure to follow the *Service Manual's* maintenance schedule recommendations may result in compromised function of the product and lead to patient injury or death.**
9. **WARNING: It is essential that clinical staff remain within visual and audible range of the pump so that critical alarms can be seen or heard and responded to.**
10. **WARNING: The user should ensure that the performance offered by the pump is fit for the intended purpose. Failure to do so may result in compromised function of the product, patient injury or user injury.**
11. **WARNING: When the pump is carrying out an infusion, to ensure that electrical safety is maintained only items of equipment that conform to EN60950 are to be connected to the RS232 connector situated at the base of the pump, otherwise patient safety may be compromised.**
12. **WARNING: Correct management of battery charging is essential to ensure that the pump can operate on batteries for the time specified. Failure to do so may lead to impaired functioning of the pump, resulting in patient injury or death.**
13. **WARNING: Do *not* use a faulty pump. If the pump develops a fault then an alarm will sound; the display will indicate a FAULT condition and the pump will fail to infuse. Incorrect performance of the pump can cause complications resulting in patient injury or death.**

    If the pump develops a fault then it must be referred to a suitably qualified engineer or returned to Graseby Medical in order to have the fault rectified.
14. **WARNING: Failure to use the mains lead clamp means that the pump may be accidentally or erroneously disconnected from the mains. Although there is battery backup in case this happens, the battery may not be sufficiently charged. Consequently there is a risk of the pump not functioning, which could lead to patient injury or death.**
15. **WARNING: If an occlusion alarm occurs, immediately clamp the line to eliminate the possibility of a bolus being delivered to the patient. Then inspect the fluid pathway for kinks, clogged catheter, etc. in order to remove the occlusion prior to restarting the infusion. An unintentional bolus of medication can result in patient injury or death.**

16. **WARNING: Use only the syringes and administration sets listed in the *Specification* (Chapter 1). Failure to do so may result in an inaccurate delivery. Smiths Medical does not guarantee performance of the pump if syringes other than those listed are used. Incorrect function or performance of the pump can cause complications resulting in patient injury or death.**
17. **WARNING: The volume of fluid contained in the connecting tubing is a residual amount and will *not* be infused. Hence this extra volume of fluid must be allowed for when initially filling the syringe and purging the system. Under-delivery of medication can cause complications resulting in patient injury or death.**
18. **WARNING: To avoid patient embolism, ensure that the patient tubing is purged of all air bubbles before administering any medication. The pump provides a purge facility to assist with this process. The presence of air within the medication can result in complications leading to patient injury or death.**
19. **WARNING: To avoid syphoning of the syringe contents (free flow), ensure that the syringe is correctly loaded into the pump, that the syringe plunger is properly engaged by the pump's actuator and that the pump is placed not more than 80cm above the infusion site. Syphoning can result in over-infusion leading to patient injury or death.**
20. **WARNING: To avoid over-infusion, do not purge the infusion line when the administration set is connected to the patient. Over-infusion of medication can result in patient injury or death.**
21. **WARNING: To avoid the pump becoming detached from an IV pole always make sure that the pump is securely fixed to the pole. Always check the security and stability of the assembly with the pump mounted.**
22. **WARNING: Following a significant liquid spill onto the pump, it should be wiped dry and inspected by service personnel before being returned to service. Failure to do so may result in compromised functioning of the pump, leading to patient or user injury or death.**
23. **WARNING: When using a syringe smaller than 50/60 ml the occlusion pressure will increase as the diameter of the syringe decreases, i.e. the smaller the syringe the higher the pressure.**
24. **WARNING: For high risk or critical infusions, the use of the dedicated 3200 Extension set incorporating the pressure sensing disc is recommended in order that occlusion pressure can be appropriately set and monitored during an infusion.**
25. **WARNING: The patient history is lost when the clock is reset.**
26. **WARNING: Only adequately qualified personnel should maintain and repair the pump.**
27. **WARNING: The pump must be disconnected from the AC power supply before the case is opened.**
28. **WARNING: The Configuration and Diagnostic mode must only be used by personnel who are adequately qualified and have previous training in the use of the pump.**
29. **WARNING: The safety and reliability of the pump may be compromised by the use of parts other than those specified in this Manual.**
30. **WARNING: When a new Syringe Size Sensor Flag has been fitted to the pump (see Appendix), then the pump must be tested using the new syringe size sensor gauges available from Smiths Medical (part number 0131-0202). Page 3 of the Appendix gives details of the Final Testing procedures.**
31. **WARNING: The pump must be set to display the brand and the size of syringe that is going to be used. Using a different brand or size of syringe to that being displayed could lead to the incorrect amount of drug being administered, that could result in injury or death.**
32. **WARNING: The internal pump batteries must be disposed of in accordance with the manufacturers instructions. Lead acid batteries must NOT be placed in the normal waste stream.**

CAUTIONS

Cautions tell you about dangerous conditions that can occur and cause damage to the pump if you do not obey all of the instructions in this manual.

1. **CAUTION: Refer all service, repair and calibrations only to qualified technical personnel. Unauthorised modifications to the pump must *not* be carried out.**
2. **CAUTION: When turning the pump on if screens similar to those illustrated are not displayed, do *not* use the pump. Send the pump to a suitably qualified engineer or return it to Smiths Medical in order to have the fault rectified.**
3. **CAUTION: Do not use cleaning and disinfecting agents other than the approved ones specified here.**
4. **CAUTION: The pump must *not* be immersed in any liquids or exposed to strong organic solvents. Wipe off spills immediately, and do not allow fluid or residues to remain on the pump. Additionally, the pump is not designed to be autoclaved, steam-sterilised, ETO-sterilised or subjected to temperatures in excess of 45° C (113° F). Failure to observe this caution may cause serious damage to the pump.**
5. **CAUTION: During the removal and replacement of a pump's components, strict observance to Electro Static Discharge (ESD) rules must be observed at all times, i.e. an earthing strap must be worn. Failure to apply ESD protection may result in serious damage to the product and possible malfunction. Ensure that any replacement printed circuit board or other ESD sensitive items are stored in an anti-static container.**

Abbreviations used

The following list shows the abbreviations that have been used at various places throughout this Manual.

Abbreviation	Full name
AC	Alternating current
A-to-D	Analogue-to-digital
C	Capacitor or Centigrade
CMOS	Complimentary metal oxide silicone
cNm	Centinewton metre
COP	Computer operating properly
DC	Direct current
D	Diode
EEPROM	Electrically erasable and programmable read only memory
EPROM	Erasable program
Fig	Figure
Hz	Hertz (cycles per second)
IC	Integrated circuit
ID	IDentification
kbyte	Kilo byte
kg	Kilo gram
KVO	Keep vein open
LC	Liquid crystal
LED	Light emitting diode
MCI	Manually controlled infusion
MHz	Mega Hertz
ml/h	Millilitre per hour
ml	Millilitre
mm	Millimetre
PSI	Pounds per square inch
PWM	Pulse width modulated
R	Resistance
RAM	Random access memory
TCI	Target controlled infusion
V	Volts
VF	Vacuum fluorescent
W	Watts

CHAPTER 1

INTRODUCTION, FEATURES and SPECIFICATION

3200

In-line Pressure Syringe Pump

CHAPTER 1

INTRODUCTION, FEATURES and SPECIFICATION

Introduction

The 3200 is a microcomputer controlled syringe pump that has primarily been developed for the neonatal infusion of sterile liquids.

The pump has an In-line (wet-side) pressure sensing system for accurate occlusion detection.

The pump is capable of operating in any one of three different infusion modes, as follows:

- continuous,
- preset, or
- intermittent.

And is able to carry out an infusion using a 5, 10, 20, 30, 50/60 ml size syringe.

The pump incorporates a dot matrix vacuum fluorescent display that provides a constant indication of the pump's operation. A choice of any one of the following languages is available (with the appropriate software) via the diagnostic options mode:

English, Dutch, French, German, Italian, Norwegian and Spanish.

The pump can be Configured by the user to work with one of a range of brands of syringe. It automatically senses the size of the syringe fitted to the pump. The rate of the pump can be set to operate with either mass units or ml/hour.

The pump is able to dispense liquids at rates of between 0.05 and 200 ml/hour.

The pump keeps the running total of the volume infused, and a history of events as they occur. About 1,500 events can be logged, complete with the date and time of each.

This compact and robust pump can be used on either a table top or mounted via its pole clamp to an IV (Intravenous) pole. The pump's history can either be viewed on the screen or output to a printer.

An RS232 interface link connects the pump to either a printer or a computer. This allows the pump's history to be printed or externally monitored.

Safety features are built into the pump and its software. This includes a set of self test routines which are run when the pump is switched on.

Users are warned of such incidents as occlusion or power failure by both visible and audible alarms.

The pump can be powered from either an AC supply or internal rechargeable batteries. The batteries can power the pump for at least two and a half hours from a fully charged condition.

A DC version of the 3200 also exists, that requires an input supply of 10 V to 28 V DC (see Chapter 9).

This Manual refers to pumps that have software Version 2.20 installed. Software versions other than 2.30 may show slight deviations from certain features described in this Manual.

Security cover

An optional security cover kit is available (part number 0131-0277). The kit includes all the items required to modify the pump, including comprehensive fitting instructions. *When fitted, the kit protects the syringe from tampering only; it provides no other security. It does not lockout the keypad or give audible or visual alarms when opened.*

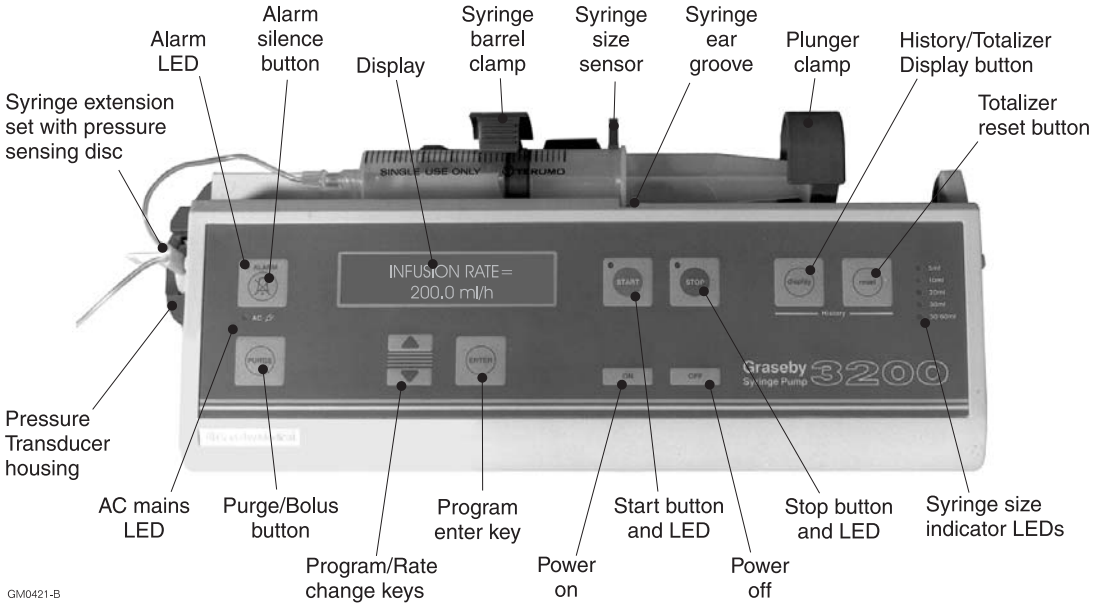


Figure 1.1 Itemised front view of the pump

Features

The key features of the 3200 are as follows:

- In-line (wet-side) pressure sensing,
- automatic syringe size sensing,
- up to 1500 History events storage,
- universal AC supply powered or battery powered,
- can be Configured to work with a range of syringe brands,
- advanced safety features,
- state-of-the-art electronics,
- clear text display,
- comprehensive range of alarms,
- RS232 interface,
- simple to use and service,
- all materials used in this product are latex free.

Micro-controller

The pump makes use of a sophisticated micro-controller which combines microprocessor facilities with the following:

- 0n-board non-volatile memory,
- RAM,
- ROM,
- an analogue-to-digital converter,
- communications circuitry,
- four 8-bit pulse-width modulated outputs,
- an internal watchdog (COP).

These facilities are usually provided by many separate silicon chips, the use of a single micro-controller greatly increases the pump's reliability.

Specification

AC power supply:

100 V to 240 V at 50/60 Hertz, 40 VA.
The power supply uses primary switching in order to utilise the AC supplies of most countries.

Battery type:

Sealed lead acid, rechargeable (Cyclon, 3 off). Smiths Medical recommend that the batteries are checked at least annually (see page 5-10).

Battery life:

More than 2.5 hours of normal pump operation when the batteries are fully charged.
With the AC supply connected, up to 14 hours are required to fully recharge low voltage batteries.

DC input operation:

3200 DC variant pump.
10 V to 28 V DC at a maximum of 4 amps input supply (see Chapter 9).

Syringe brands and sizes:

BD Plastipak...	5, 10, 20, 30/50 and 50/60 ml.
Injectomat...	10 ml and 50 ml.
IMS Pumpjet...	30 ml, prefilled.
Monoject...	5, 10, 20, 30/35 and 50/60 ml.
Braun Omnifix...	5, 10, 20, 30 and 50/60 ml.
Terumo...	5, 10, 20, 30/35 and 50/60 ml.
BD Plastipak (A)...	5, 10, 20, 30/35 and 50/60 ml.

The BD Plastipak (A) syringe accommodates the American manufactured 10 ml syringe, which differs slightly in length to the European version. All other syringe sizes in the BD Plastipak selection are identical to the standard BD Plastipak syringes.

Braun Perfusor... Optional (see Chapter 8).

Infusion rates and increments:

Rates	Increments
0.05 to 1.0 ml/h...	0.01 ml/h
1 to 200 ml/h...	0.1 ml/h
0.01 to 999 mg/kg/h	
0.01 to 999 mg/kg/min	
0.01 to 999 µg/kg/h	
0.01 to 999 µg/kg/min	
0.01 to 999 mg/h	
0.01 to 999 µg/h.	

Mass unit programming range:

Patient weight...	0.4 to 200 kg.
Drug mass...	1 µg to 999 mg.
Drug volume...	1 ml to 60 ml.

Volume infused counter:

0 to 999.9 ml in 0.1 ml increments.

Specification (contd.)

In-line occlusion pressure range:	Using a 30 ml sized syringe: 0 to 7.42 kg (1000 mmHg). 0 to 1355 cmH_2O. 0 to 133.3 kPa. 0 to 1316 mBar. 0 to 19.34 psi. Using a 50 ml syringe, 0 to 4.83 kg (0 to 650 mmHg).
Internally adjustable occlusion pressure:	Using a 50 ml syringe, 1.85 kg (250 mmHg) to 4.83 kg (650 mmHg).
Factory set occlusion:	3.5 kg (471 mmHg) to 4.2 kg (565 mmHg).
Display languages available:	Dutch. English. French. German. Italian. Norwegian. Spanish.
Dimensions:	350 x 195 x 115 mm, with pole clamp fitted and plunger clamp closed.
Weight:	Not exceeding 3.5 kg including the batteries and pole clamp.
Temperature range:	Operating conditions: +5°C to +40°C, 30 to 75% Rh, 700 to 1060 hPa. Storage conditions: -40°C to +70°C, 30 to 90% Rh, 700 to 1060 hPa.
Drive accuracy:	±2%.
History:	1500 events can be stored.
Electrical safety:	Class II Type CF Drip proof IPX1.
Design standards:	BS5724 Part 1 IEC601 Part 1 VFG1046/1984.
UK patent number:	2229497.
Printer protocol:	Serial, 8 bits, no parity, 1 stop bit.

Brief history of Graseby bedside syringe pumps

MS2000
The first Graseby bedside syringe pump was the **MS2000**. This was a basic syringe pump capable of infusions within the range of 0.1 ml/hr to 99.9 ml/hr. It had a totaliser, a limited infusion capability, a built-in pole clamp and was designed for vertical operation. The MS2000 was powered by an AC supply or its internal DC batteries. This pump is no longer manufactured.

PCAS
The **PCAS** pump was developed from the MS2000 to satisfy the growing interest in Patient Controlled Analgesia (PCA). The PCAS was very similar to the MS2000 in both appearance and mechanical design, but used a different microprocessor with the capability of running the extra features required for PCA. It was eventually replaced by the 3300 pump. A printer port was also incorporated. This pump is no longer manufactured.

3000
The first pump in the 3000 Series of syringe pumps was the **3000**. This pump was a low-cost alternative to the MS2000 and satisfied the need for a horizontally mounted pump. The 3000 did not have an internal battery supply. This pump is no longer manufactured.

3100
The **3100** syringe pump was developed from the 3000. It is very similar mechanically but with improved electronics. Dual processors were incorporated, with a vacuum fluorescent text display and internal batteries. The maximum infusion rate was increased to 199.9 ml/hr and different syringe sizes were able to be used (automatically sensed). Extra software features, such as the intelligent 'near end' alarm, were also incorporated.

3300
The next bedside syringe pump to be developed was the **3300**. This was similar in mechanical and electronic design to the 3100 but the features were specifically for the now more mature PCA market. A lockable syringe cover was added for security against drug theft; a four line LC display was added and internal history recording (1500 events) with printout was also added. With the growth in PCA knowledge in the medical community, many more software features were incorporated into the 3300 to aid PCA administration.

3400
The **3400** was developed (again from the 3100) to satisfy the need for a high speed infusion pump for intravenous anaesthesia. Advances in micro-controller technology allowed the use of a single device to control all the pumps features. The maximum infusion rate was raised to 1200.0 ml/hr and bolusing facilities were also added. An infusion rate calculation facility was later added to the software.

A larger liquid crystal display was used on the 3400 with the ability to display text in different sizes, also 'soft-keys' were used to make the user interface simpler. The range of syringe sizes that could be used was also increased. For more advanced applications the pump could be controlled by a computer.

3200
The 3200 was developed as a general purpose syringe pump. Wet-side pressure sensing, intermittent infusion capabilities, and computer interfacing were added. The wet-side occlusion pressure monitoring made the pump particularly suitable for use in intensive-care baby units. A large text vacuum fluorescent display was added, and the increased syringe size range of the 3400 remained.

A DC input supply (10 V to 28 V DC) version of the 3200 is also manufactured by Smiths Medical. This variant is primarily intended for use in an aviation environment, but may be utilised in an environment where the required DC voltage exists.

3500
There are two versions of the 3500, as follows:
1. A Manually Controlled Infusion (MCI) *only* pump.
2. An MCI *plus* a Target Controlled Infusion (TCI) pump.

The 3500 was developed from the 3400 and retains all the 3400 facilities.

The 'MCI *plus* TCI' pump carries out a TCI using the Diprivan drug. This version of the 3500 incorporates a Diprifusor module manufactured by Zeneca Pharmaceuticals. A new main circuit board and new software allows the 3500 to interface with the Diprifusor module. A 3500 non-TCI pump can be converted to become a 3500 plus TCI pump.

3150
The 3150 is very similar to the 3200 general purpose pump. The main difference being that the In-line (wet-side) pressure sensing system in **not** available on the 3150, i.e. the pressure transducer is not fitted.

CHAPTER 2

CONFIGURATION, DIAGNOSTICS and OCCLUSION THRUST

3200

In-line Pressure Syringe Pump

CHAPTER 2

CONFIGURATION, DIAGNOSTICS and OCCLUSION THRUST

Configuration mode

WARNING

The Configuration mode must only be used by personnel who are adequately qualified and have had previous training in the use of the 3200.

Introduction

The Configuration mode allows the various different pump parameters to be displayed, which in turn allows various settings within these parameters to be set to the values required for the infusion.

The full list of Configuration parameters is shown below, but the availability of some parameters depends upon the setting of other parameters. Each parameter is further detailed in the sections that follow this list:

1. Syringe brand.
2. Syringe size.
3. Lock program values.
4. Max infusion rate.
5. Select pump modes.
6. Preset volume mode with time.
7. KVO rate.
8. Allow mass unit.
9. Infusion units, mg/kg/h.
10. Infusion units, µg/kg/h.
11. Infusion units, mg/kg/min.
12. Infusion units, µg/kg/min.
13. Infusion units, mg/h.
14. Infusion units, µg/h.
15. Show rate in ml/h while infusing.
16. Use pressure transducer.
17. Display pressure bar graph.
18. Allow bolus while running.
19. Allow rate change while running.
20. Intermittent mode start delay.
21. RS232 Baud rate.
22. Communication mode.
23. Pump ID.
24. Set key beep volume.
25. Pressure units.
26. End of menu.

Entry into the Configuration mode

With the pump switched on and in the set-up mode, complete the following procedures to enter the Configuration mode.

Press and hold down the **PURGE** button. Press either the ▲ or ▼ button. The following is displayed:

```
CONFIGURATION MODE ?
  (USE WITH CARE)
```

Within six seconds of pressing the buttons, press the **START** button to confirm the configuration mode.

Note:
If the **START** button is not pressed within six seconds, the pump returns to its set-up mode.

A display similar to the following will be shown:

```
   SYRINGE TYPE=
    BD PLASTIPAK
```

Changing a setting

Press the ▲ or ▼ button sequentially to scroll through the settings available within each parameter. The setting required must be displayed.

The various settings are retained by the pump until the Configuration mode is re-entered and the setting reset.

Moving to the next parameter

Press the **ENTER** button to move to the next parameter. If a new choice is required, repeat the above. Sequentially pressing the **ENTER** button scrolls through the available Configuration parameters.

To exit the Configuration mode and return to the set-up mode press the **STOP** button at any time.

Available Configuration mode parameters and settings

Syringe brands 1.

WARNING

The pump must be set to operate with the brand and size of syringe that is going to be used. Using a different brand to that selected could lead to the incorrect amount of drug being administered, resulting in injury or death.

The syringe parameter allows a choice of any one of eight different syringe brands to be pre-selected and used during an infusion.

Choice: BD PLASTIPAK
INJECTOMAT
IMS PUMPJET 30
MONOJECT
BRAUN OMNIFIX
TERUMO
BD PLASTIPAK (A), see page 1-4.
BRAUN PERFUSOR, optional syringe. See Chapter 8.

Syringe size 2. This parameter allows the five syringe sizes that are available to be locked to any one size, thus excluding the other four settings, or NOT LOCKED in order to accept all five choices.

Choice: 5 ml ONLY
10 ml ONLY
20 ml ONLY
30 ml ONLY
50/60 ml ONLY
NOT LOCKED

Lock program values 3. After the required infusion program values have been set into the pump (i.e. during the set-up mode) this parameter allows these set-up program infusion values to be temporarily locked in. This prevents tampering and is useful for home treatment.

The lock must be turned off (i.e. the lock program value set to NO) to change the set-up infusion mode.

Choice: YES or NO

Max infusion rate 4. This parameter allows the maximum infusion rate to be set. Above the set rate, an alarm message is displayed; the pump will not infuse.

The infusion rate that is initially entered into the pump in the set-up mode acts independently of the maximum infusion rate that can be entered in the configuration mode.

The configuration mode maximum rate setting takes priority with respect to the maximum infusion rate that can be used.

The Instruction Manual details the maximum infusion rates for the five different syringe sizes that are available.

Choice: 10 to 200.0 ml/h in 0.1 ml steps.

(contd.)

Select pump modes

5. This parameter shows the versatility of the 3200 by allowing five different combinations of the three modes of infusions to be pre-selected.

Choice: ALL MODES AVAILABLE
CONTINUOUS & PRESET
INTERMITTENT ONLY
PRESET VOLUME ONLY
CONTINUOUS ONLY

Preset volume mode with time

6. This parameter allows either a preset volume with time (YES selected) or a preset volume with rate (NO selected).

Choice: YES or NO.

KVO rate

7. This parameter allows either a KVO rate of 0.50 ml/h or 0.05 ml/h to be chosen.

Choice: 0.5 ml/h or 0.05 ml/h.

Allow mass units option

8. When **YES** is chosen this parameter allows any one of the six mass units to be selected [see parameters (9) to (14)].

When **NO** is chosen this parameter allows only ml/h to be selected.

Choice: YES or NO

Infusion units

When **YES** is chosen from parameter (8), parameters (9) to (14) allow any combination of mass units from the following list:

9. mg/kg/h.
10. µg/kg/h.
11. mg/kg/min.
12. µg/kg/min.
13. mg/h.
14. µg/h.

Choice: YES or NO for each parameter.

Show rate in ml/h while infusing

15. This parameter allows the infusion rate, when set to mass units, i.e. **YES**, to also be displayed in ml/h when infusing.

Choice: YES/NO

(contd.)

Use pressure transducer 16. This parameter allows a selection of in-line pressure sensing options.

If **YES** is chosen, the pump senses the presence of a syringe extension set and shows the in-line pressure on the display.

If the extension set is not being used, choosing **YES** causes the following prompt to appear when the **START** button is pressed...

Press **START** to run without disposable

This display serves as a warning that the extension set is not being used. Pressing the **START** button a second time runs the pump without the extension set.

Choosing **NO** also allows the pump to run without the extension set.

Choice: YES or NO

Display pressure bar graph 17. This parameter allows the pressure bar graph to be displayed when **YES** is chosen.

If **NO** is chosen, the display will be similar to the following:

10 mmHg (75)

Choice: YES or NO

Allow bolus while running 18. If **YES** is chosen this parameter allows the **PURGE** button to infuse a bolus when the pump is running.

Choice: YES or NO

Allow rate change while running 19. If **YES** is chosen, this parameter allows the infusion rate to be changed during the actual infusion.

The infusion can thus be titrated to the physiological response of the patient.

Choice: YES or NO

Intermittent mode start delay 20. In the Intermittent mode, this parameter allows a start delay between 0 and 24 hours to be chosen before the intermittent regime is started.

Choice: YES or NO

RS232 Baud rate 21. This parameter allows a choice of Baud rates when the pump is connected to a PC or a printer.

Choice: 9600
4800
2400
1200
600
300

(contd.)

Commun-ication mode 22. This parameter allows a computer to interrogate both the information stored in the pump and the pumps status.

Choice: MONITOR ONLY.. this choice allows an external computer or a printer to be connected to the pump.

NONE... this choice ensures that a computer cannot be used to monitor the pump.

Contact Smiths Medical (Customer Support) for information on setting up a computer link.

Pump ID 23. The identification (ID) of the pump appears on the initial power up display. It also appears on the printout.

This parameter allows an ID of up to 12 alphanumeric characters to be chosen.

To change the pump's ID use the **START**, ▲ or ▼ and **ENTER** buttons, and press **STOP** when finished.

A typical ID display is shown below:

GRASEBY-3200

The pump ID accepts 12 characters exactly. A blank space is not provided.

Set key beep volume 24. This parameter allows the sound of the key beep to be adjusted so that it is at an appropriate level for the existing environment.

Choice: 1 to 10.
1 is quiet.
10 is loud.
As the choice is altered from 1 to 10, the sound level increases.

Pressure units 25. This parameter allows any one of five choices to be made for the in-line pressure sensor display, as shown below:

Choice: mmHg.
mbar.
cmH2O.
psi.
kPa.

End of menu 26. Press the **STOP** button to exit from the configuration mode.

Diagnostic mode

WARNING

The Diagnostic mode must only be used by personnel who are adequately qualified and have been trained in the use of the 3200.

Introduction

The Diagnostic mode has seven available options which can be used to view, select and complete the procedures detailed in the following sections.

The Diagnostic options are:

- Software version.
- Calibrate transducer.
- Battery voltage.
- Language.
- Number of faults.
- Total volume infused.
- Total hours of use.

Entry into the Diagnostic mode

To enter the Diagnostic mode, complete the following procedures with the pump switched on:

Press and hold down the **ALARM** button and press either the ▲ or ▼ button. The following is displayed:

```
DIAGNOSTIC MODE ?
 (USE WITH CARE)
```

Within six seconds of pressing the buttons, press the **START** button to confirm the Diagnostic mode is required:

Note:
If the **START** button is not pressed within six seconds of the display appearing, the pump will return to its set-up mode.

A display similar to the one shown below appears:

```
SOFTWARE VERSION=
     2.30
```

Moving to the next display

Press the **ENTER** button to move to the next display. Sequentially pressing the **ENTER** button scrolls through the available Diagnostic displays.

Press the **STOP** button at any time in order to exit the Diagnostic mode and return to the set-up mode.

Diagnostic displays

Software

1. The software display shows the version of software installed in the pump. It is similar to the following display:

```
SOFTWARE VERSION=
    2.30
```

Calibrate transducer

2. To calibrate the transducer, both a syringe extension set and a mercurial sphygmomanometer (or a similar pressure reading device) are used.

   Insert the pressure sensing disc into the pump's sensor housing and attach the disc to the pressure reading device.

   In the Diagnostic mode, scroll through the displays until the following display appears:

```
  PRESS START TO
CALIBRATE TRANSDUCER
```

Press the **START** button and the following display is shown:

```
  SET ZERO mmHg
AND PRESS START
```

Set the pressure reading device to zero mmHg and then press the **START** button.

The following two displays automatically appears:

```
    ZEROING
  PLEASE WAIT
```

```
   SET 300 mmHg
AND PRESS START
```

Set the pressure reading device to 300 mmHg and press the **START** button.

The following three displays automatically appear:

```
   CALIBRATING
   PLEASE WAIT
```

```
   CALIBRATION
     COMPLETE
```

```
  PRESS START TO
CALIBRATE TRANSDUCER
```

After carrying out the previous display request (i.e. pressing **START**), press **STOP** to return the pump to its set-up mode.

Transducer alarm

If a fault occurs within the transducer set-up system, a pulsing loud alarm (silenceable) occurs and the following alarm display appears:

```
WARNING: CANNOT
CALIBRATE TRANSDUCER
```

Battery voltage

3. The battery voltage display is similar to the following:

```
BATTERY VOLTAGE=
     6.9 V
```

Language

4. Various languages may be selected and used for display purposes. The English display selection is shown below:

```
LANGUAGE=
ENGLISH
```

The other language displays are:

- SPRÅK = SVENSKA
- TAAL = NEDERLANDS.
- LINGUA = ITALIANO.
- SPRACHE = DEUTSCH.
- LANGUE = FRANCAIS.

Number of faults

5. The total number of faults that may have occurred to the pump since manufacture is displayed when in this parameter:

```
NUMBER OF FAULTS=
       1
```

Volume infused

6. The total volume of liquid that has been infused since the pump was manufactured is displayed when in this parameter:

```
TOTAL VOLUME INFUSED
    0.06 litre
```

Hours of use

7. The total number of hours that the pump has been switched on is displayed when in this parameter is selected:

```
TOTAL HOURS OF USE=
     9.0 hours
```

Setting the clock

The time and date may be viewed; if required, both may be reset. The procedures for entering and setting the clock are detailed below.

Entering the clock display

Simultaneously press the...

ALARM, ENTER and **DISPLAY** button,

and a display similar to the one shown below appears:

```
     SET CLOCK ?
15:19:22   31-AUG-2003
```

Within six seconds of pressing the buttons, press the **START** button to amend the time and/or date.

Note:
If the **START** button is not pressed within six seconds of the display appearing the pump returns to its set-up mode.

A display similar to the one shown below is displayed:

```
     NEW TIME=
15:19:22   31-AUG-2003
```

Initially the hours indication in the above display blink on-and-off. Use the ▲ or ▼ buttons to set the hours.

By pressing the **START** button, the

'minutes, seconds, day, month and year'

can in turn be highlighted. Use the ▲ or ▼ buttons to change any selection or all of the settings.

Press the **STOP** button to return the pump to the set-up mode.

Disassembly and assembly of casing

WARNING

The following procedures must only be carried out by qualified technicians.

ELECTRIC SHOCK HAZARD

The pump *must* be disconnected from the AC power supply before opening the casing.

The casing must be opened to carry out adjustments that may be required to the occlusion thrust and for various repair procedures.

Repair procedures are detailed in Chapter 5.

Each time the casing separated and reassembled, the syringe size functional tests detailed on page 6-1 must be completed.

Taking the casing apart

1. Disconnect the AC power connector and utilising a scratch free flat surface, turn the pump over to gain access to the base.
2. Undo and retain the six screws that hold the casing halves casing together. One of the screws is situated in a channel in the rear cover.
3. From the top of the pump carefully ease the casing halves apart, taking care not to put any strain on the internal connecting cable looms that form a hinge between the casing halves.

Assembly

Being careful not to trap any leads, assemble the casing by reversing steps (2) and (3) detailed above. Ensure that the case halves have 'snapped' together and that the front and rear mating edges are equal and parallel. Tighten the screws to a torque of between 70 and 75 cNm in the order shown in the *Figure 2.1*.

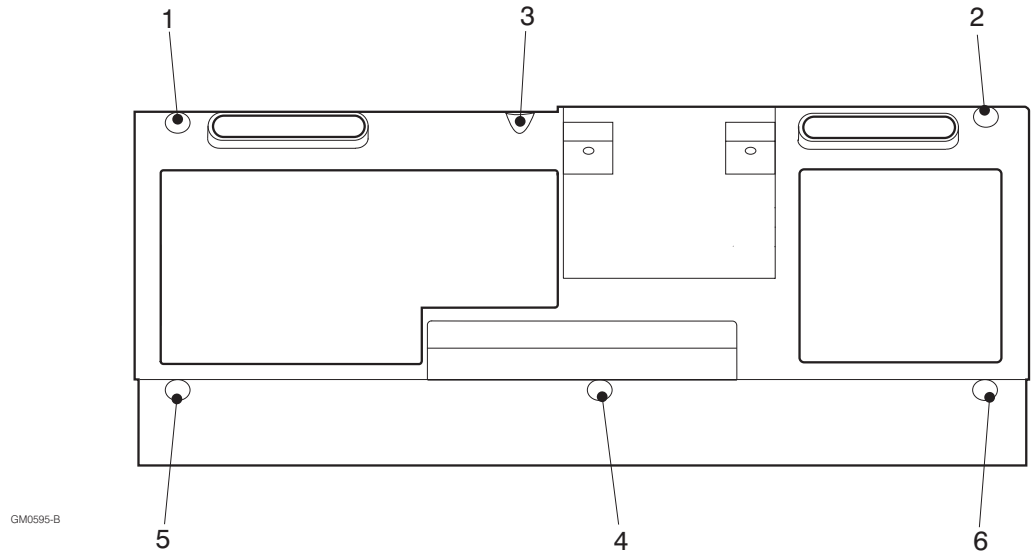


Figure 2.1 Case fixing screw tightening order

Occlusion measurements

The two most frequently used methods to measure the point at which an occlusion occurs are the **thrust** and **pressure** methods.
Currently, the occlusion is set in the factory by using a **thrust** measurement procedure. This method measures the plunger clamp thrust by using a set of weights (see next page).

The occlusion **pressure** is obtained by measuring the pressure that occurs in the infusion line. The in-line method requires the use of a new syringe and infusion line. Conversion between the two is achieved using the formulae below, taking into consideration syringe stiction.

The 3200 has the ability to measure in-line occlusion pressure, when using the dedicated disposal. See page 3-2.

The internal occlusion sensing system within the pump is always active.

Thrust measurements

Translation of the thrust depends on the syringe diameter and the stiction of the syringe. The formula for calculating the thrust is given below:

$$T = \frac{P \times A}{732} + \frac{S}{1}$$

where: **T** = thrust in kg.
P = delivery pressure in mmHg.
A = cross sectional area of the syringe in cm^2.
and **S** = syringe stiction in kg.

The occlusion thrust of the pump is factory set to be between two limits (i.e. a minimum and a maximum tolerance). The customer may reset the thrust for their own particular requirement. The thrust of a pump may, therefore, differ from the original factory set levels.

The occlusion thrust of the 3200 pump is factory set to be between 3.5 kg and 4.2 kg (471 mmHg and 565 mmHg).

Syringe stiction

Stiction for a syringe varies from brand to brand as well as from batch to batch. Stiction can be as low as 0.1 kg and as high as 2 kg. The stiction of some syringe brands has been found to be particularly high.

Stiction can also vary along the plunger travel and is usually lowest in small diameter syringes. Using a sample syringe and allowing for a safety margin for sticky syringes, adjustments can be made by measuring the thrust generated. If the stiction characteristics of a syringe are known then by using the formula given above the occlusion thrust can be set.

Thrust checks

The following thrust checks use the weights that correspond to the factory-set occlusion threshold levels for a 3200 (i.e. 3.5 and 4.2 kg). If a different occlusion level setting is required, the weights must be adjusted accordingly.

The thrust adjustment procedures are shown on page 2-14.

1. Set the pump's plunger clamp to approximately midway along its support tube.
2. Remove the plunger from a BD 60 ml syringe and saw the end off the syringe. Place the modified syringe onto the pump so that it will act as a guide for the weight support rod and also position the size sensor flag (see *Figure 2.2*).
3. With the pump switched **ON**, set the infusion rate to 200 ml/hr.
4. Place the pump in a vertical position, with its left hand side uppermost (see *Figure 2.2*).
5. Place the weight support rod through the modified syringe and onto the pump's plunger clamp.
6. Place a weight of 3.5 kg on top of the weight support and check that the pump operates for between 30 and 60 seconds and does **not** occlude (i.e. the alarm does not sound). Remove the weight.
7. Place a weight of 4.2 kg on top of the weight support and check that within 60 seconds the pump does occlude (i.e. the alarm sounds).

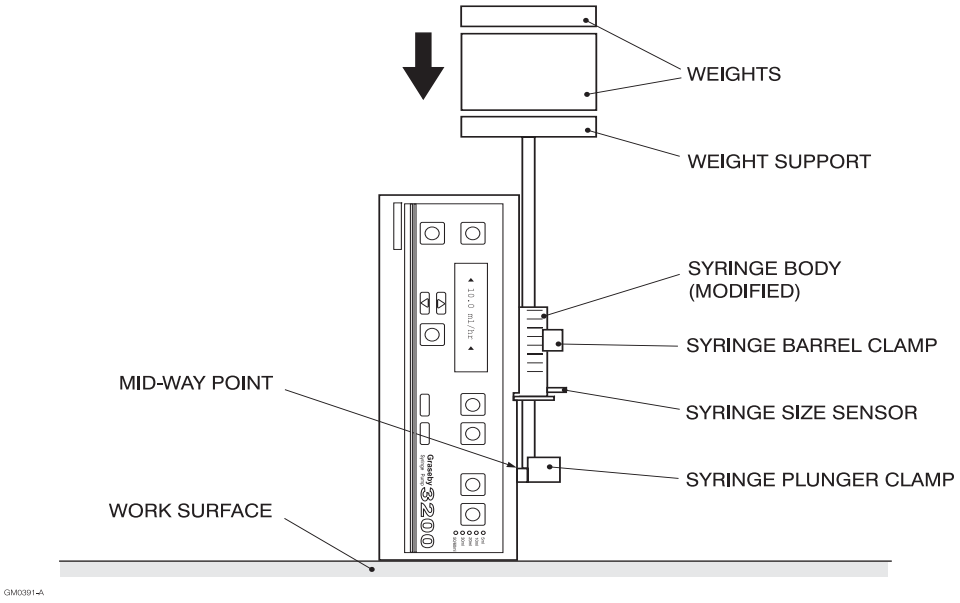


Figure 2.2 Thrust measuring set up

Thrust adjustments

If the occlusion thrust requires adjustment, the following procedures must be completed:

1. Switch the pump off and disconnect the AC supply.
2. Take the casing apart (see page 2-11).
3. If necessary, rotate the leadscrew to reveal the grub screw located on the occlusion adjusting nut. Loosen the grub screw with a 1.5 mm hexagonal key.
4. Alter the setting of the occlusion adjusting nut as necessary. One full turn of the adjusting nut using a 50\60 ml syringe gives approximately 2.73 kg (369 mmHg) of adjustment.

Rotating the adjusting nut to decrease the tension on the leadscrew spring. This decreases the pump's occlusion setting.

Rotating the adjusting nut to increase the tension on the leadscrew spring increases the pump's occlusion setting.

5. Tighten the grub screw to a torque of 15 ± 2cNm.
6. Temporarily assemble the two halves of the pump, being careful not to trap any leads.
7. Complete a thrust check (see page 2-13).
8. To obtain the thrust required it may be necessary to repeat steps (2) to (7) above.
9. Assemble of the pump casing (see page 2-11).
10. Complete tests No. 9 and 10 detailed in the functional test procedures (see page 6-3).

CHAPTER 3
FUNCTIONAL DESCRIPTIONS

3200
In-line Pressure Syringe Pump

CHAPTER 3

FUNCTIONAL DESCRIPTIONS

Introduction

This Chapter explains how the 3200 operates. Reading this chapter will help a technician to rectify any possible faults that may occur within the pump.

The functional descriptions of the 3200 may be divided into six separate areas. Each of these functional descriptions are detailed separately in the sections following this list:

- Drive system.
- Internal occlusion system.
- In-line occlusion system.
- Electro/mechanical control system.
- Sensing (alarm) systems.
- Software.

Drive system

Introduction

The motor, gearbox, leadscrew and associated components (*Figure 7.1*) are mounted on a glass reinforced polycarbonate casing. The strength of this casing enables a precise mechanical location to be achieved for the various components.

Both the inner and outer metal tubes are made of substantial material in order to eliminate unwanted flexing.

Stepper motor and leadscrew

The drive system comprises a stepper motor working through a gearbox which rotates a leadscrew. A half nut/super nut assembly engages onto the leadscrew, and the assembly is also connected to a steel tube. The steel tube is connected to the plunger clamp.

The rotation of the leadscrew moves the plunger clamp. This movement pushes ‘in’ the plunger on the syringe being used (see below).

As the motor spindle rotates, the leadscrew also rotates and the half nut/super nut assembly travels to the left - along the leadscrew. The half nut assembly pulls the outer of two steel tubes to the left. This outer tube travels over and along a support tube; the support tube is almost the length of the pump.

Micro-computer

The microcomputer and its associated software determines the speed of the motor.

Toggle mechanism

A spring-loaded toggle mechanism is attached to the bottom of the half nut/ super nut. The toggle mechanism enables the plunger clamp to be physically swung ‘in or out’ thus rotating the outer metal tube so that the half nut is either fully ‘engaged or disengaged’ (respectively) from the leadscrew.

Plunger clamp

When the plunger clamp is pulled down, the half nut/super nut engages with the leadscrew and the clamp engages with the end of the syringe.

The syringe plunger slots into place behind a slotted pair of lips. These lips prevent the syringe plunger from moving forward in the event of negative pressure on the syringe.

Two small push-buttons on the edge of the plunger clamp make contact with the top of the syringe plunger. These push-buttons control the operation of a lever which protrudes from the plunger clamp.

When the push-buttons are pressed in, by coming into contact with the top of the syringe, the lever becomes free and is able to retract into the plunger clamp. This retraction takes place when the plunger clamp is physically swung into its down operating position.

If the push-buttons are not pressed 'in', the lever is locked in its protruding position thus preventing the plunger clamp from being pulled down. This in turn prevents the half nut from engaging on the leadscrew.

This push-button safety system prevents the leadscrew from being engaged unless the top of the syringe is correctly positioned in the plunger clamp.

If the plunger clamp is accidentally dislodged during an infusion, the pump will automatically and safely stop infusing. The alarm will sound.

Internal occlusion system

An occlusion sensing assembly located at the left hand end of the leadscrew (*Figure 7.1*) causes the rotating leadscrew to turn a slotted disc. The rotation of this disc is detected by an opto-sensor.

A spring mechanism at the right hand end of the leadscrew provides the pressure that is required in order to overcome any slight resistance from the syringe plunger.

If an occlusion occurs in the syringe line and the occlusion pressure is sufficient to overcome the spring pressure, the leadscrew moves slightly to the right, thus losing contact with the clutch. The slotted disc stops rotating. This non-rotation of the slotted disc is detected by the opto sensor and an occlusion alarm is generated.

This method of occlusion detection is extremely sensitive as it is the lack of pressure on the clutch that generates the alarm, rather than a detection of the movement of the leadscrew, as used in traditional designs (UK patent no. 2249497).

In-line occlusion system

The method of directly measuring the pressure in the infusion line allows a more accurate measurement of the lower occlusion pressures to be made, thereby making the pump ideally suited for neonatal infusions.

The infusate flows through a disposable pressure sensing disc which is part of the pressure sensing assembly (*Figure 7.1*).

The sensing disc has a chamber which is covered by an elastic membrane. As the pressure in the infusion line increases, the pressure exerted on the membrane also increases.

The membrane in turn presses against a pressure transducer mounted on the side of the pump. The pressure transducer is covered by an insulating film to prevent the ingress of foreign particles.

(contd.)

The above action causes a voltage proportional to the pressure in the infusion line to be input to one of the channels of the 8 bit A-to-D converter in the micro-controller.
If the output from the A-to-D converter exceeds the predetermined value set by the user, an in-line occlusion alarm is generated.

The presence of a pressure sensing disc on the pump is confirmed by an opto-sensor which is located at the bottom of the sensor housing. If the sensor detects that the sensing disc has been removed during an infusion, an alarm is generated.

Electro/mech control system

The microprocessor provides the pulse train for the stepper-motor to produce the set flow rate. The rotation of the leadscrew slotted disc (see page 3-2, Internal occlusion system) is monitored by the opto-sensor.

If the appropriate pulses are not detected by the opto-sensor, an alarm is generated.

The mechanical characteristics of the system are:

- motor step angle: 15 degrees
- gearbox reduction ratio: 210:1
- number of motor steps per revolution of leadscrew: 5,040 at all times
- leadscrew pitch: 1.5 mm
- syringe characteristic: 1 ml/1.8 mm (BD 60 ml syringe)

Sensing (alarm) systems

Introduction

In addition to the occlusion sensing system (page 3-2), the following sensing systems are also operative within the pump.

End of infusion

A metal flag protrudes from the left hand side of the half nut in parallel with the leadscrew. As the syringe plunger reaches the end of its travel, the flag de-activates opto-sensor OPT00 situated on the opto sensors board. When the microprocessor detects that this sensor is de-activated and the slotted disc is no longer rotating, it generates an END OF INFUSION/EMPTY alarm.

Syringe nearly empty

When the metal flag de-activates opto-sensor OPT00 and the slotted disc is still rotating the microprocessor makes a calculation (dependent upon the infusion rate) and issues a NEARLY EMPTY alarm three minutes before the end of the infusion.

AC power failure

The sensing system will detect an AC power failure.

The pump continues to run after an AC power failure for a period of 2.5 hours or more by switching automatically to the pump's internal (fully charged) batteries.

Battery voltage low

The sensing circuits incorporate a system that monitors the output of the batteries and registers an alarm if the voltage of the batteries drops below 5.75 V.

If the voltage falls below 5.4 V the pump turns itself off after an initial warning period.

Self tests/pump malfunction

At switch on the pump completes various self tests. In addition, the rotation of the slotted disc at the end of the leadscrew is monitored to ensure that the drive mechanism is operating correctly.

The software continually checks itself for the validity of the calculations.

Drive disengaged or syringe not fitted

The pump's drive system is designed so that it is only engaged when the top of the syringe is correctly positioned in the plunger clamp.

If the plunger clamp is displaced during an infusion, the drive automatically stops due to the disengagement of the half nut. The disengagement of the half nut is detected by an opto-sensor.

If the pump tries to operate without a syringe, or with a syringe incorrectly fitted, the pump goes into an alarm state.

Syringe sizing system

The syringe sizing system comprises a flag moulding assembly (*Figure 7.2*) that rests on the barrel of the syringe. In conjunction with three size sensors (*Figure 7.6*), it measures the diameter of the syringe being used.

The flag moulding rotates about the outer of the two guiding tubes and moves an actuating flag between the three size sensors.

The flag is able to de-activate the three size sensors in any one of the following combinations:

none; 1; 1-2; 1-2-3; 2-3 or 3.

Depending on the operation of the size sensors, the pump monitors the size of a syringe as being 5 ml, 10 ml, 20 ml, 30 ml or 50/60 ml.

Alternatively, if a syringe is not fitted onto the pump or a syringe smaller than 5 ml is fitted, then the

SYRINGE INVALID

alarm is activated.

Rate setting

For each size of syringe, there is a maximum rate at which the pump is able to infuse. The syringe size maximum rate can be constrained to an absolute maximum rate by using the associated parameter within the Configuration mode.

When an infusion is started, the pump checks that the maximum rate constraints have not been exceeded.

In Intermittent mode, an alarm message is given if any of the following conditions occur:

- the dose volume is too large,
- if the background rate is too high,
- if the cycle time is too short, or
- if the sdose duration is too long or too short.

Cannot zero extension set

When the pump is switched on with a disposable syringe extension set fitted, the user is alerted that an auto zero has not been carried out.

Cannot calibrate extension set

An alarm is generated if an extension set calibration is unsuccessful.

A range of 0 to 1000 mmHg is specified for the extension set, with an offset of +/-100 mmHg. If this offset is exceeded, an unsuccessful calibration alarm is generated.

If the extension set is removed from its housing while the pump is running an alarm condition will be activated.

Communications (RS232) failure

When under the control of an external computer, an alarm is generated if a computer failure or disconnection is detected.

Software

Self tests

The 3200 self tests include the following:

- ROM test (CRC-16),
- RAM test,
- power supply voltage test,
- keyboard test (this test checks for shorted keys),
- stack usage test, and
- motor windings continuity test.

Design

The program is held in a 256 Kbyte EPROM.

The configuration data and settings are stored in the processor's EEPROM.

A 32 Kbyte RAM chip holds the history. The history will be lost if the AC supply to the pump is switched off or disconnected and the internal batteries unplugged.

CHAPTER 4
CIRCUIT DESCRIPTIONS

3200
In-line Pressure Syringe Pump

CHAPTER 4

CIRCUIT DESCRIPTIONS

Introduction

This Chapter describes the action of the circuits that operate the 3200. It also shows the associated circuit diagrams and circuit board layouts.

The 3200 contains six circuit boards as follows:

- Main.
- Regulator (power supply).
- Syringe size sensors.
- Status sensors.
- Distribution.
- Pressure sensing module.

The overall block diagram for the 3200 is shown in *Figure 4.1*.

The status sensor, syringe size sensor and the pressure sensing module boards provide a mounting for the various sensors, and also junction points for the outputs of these boards, thus enabling the outputs to be connected to other circuits.

Main board

The block diagram for the Main board is shown in *Figure 4.2*. It comprises the following sub-circuits which are individually described in the sections that follow:

- Processor core.
- Motor interface.
- Power control.
- Sensors and pressure sensing interface.
- RS232 serial interface.
- Umbilical connector.
- Input/output interface.

Processor core

The Processor core forms part of the Main board (see *Figure 4.2*). It is used to process all the operating activities of the 3200.

The Processor core circuit is shown in *Figure 4.3.*

The microprocessor chip (IC14) has an on-board EEPROM which stores the programmed settings. IC14 also incorporates an on-board RAM; an Analogue-to-Digital (A-to-D) converter; timing circuitry; 4 pulse width modulated outputs; communications circuitry and an internal watchdog.

The processor has the ability to address both the paged RAM and the EPROM. The 32K RAM (IC12) is split into four 8K pages, and the EPROM (IC13) is divided into thirty-two 8 K pages. The paging system is part of the integral memory management system of the processor.

IC15 is the microprocessor supervisor chip and has four main duties: to control the microprocessor reset; battery backup switch-over; watchdog timer and CMOS RAM write protection during power down.

Crystal X1 and its associated components R63, C32 and C33 form a 16 MHz oscillator, providing clock pulses for the main-processor on pins 67 and 68.

Pins 70 and 71 on the main-processor are used to control its mode of operation. Both pins are held high to set the processor to address the external EPROM (IC13). Pins 44 and 43 are held at Vcc and ground respectively, as the reference inputs to the processor's built in A-to-D converter.

Pin 21 receives pseudo non-maskable interrupts generated by the supervisor circuit in the event of a system fault being detected.

Pulse Width Modulated (PWM) output PW3, pin 14, controls the offset trim for the pressure sensing system, and output PW4, pin 15, controls the sounder volume. Pins 12 and 13 are not configured as PWM outputs, they are used to activate FPSEL1 and FPSEL2 which define which input/output chips to activate.

IC12, the RAM chip, is used as a buffer for the RS232 interface. IC12 also provides a duplicate of critical data stored in the on-board RAM so that corrupted data may be detected.

The EPROM chip IC13 stores the system's software.

IC16 is a real time clock, and crystal X2 provides the reference signal for the clock. When the pump is switched on, the processor reads the time and date received from IC16, and when the clock is changed the real time clock's data is also changed.

The input from the pressure sensing interface circuit, SENSE1, to the A-D converter on the processor is conditioned by a technique called dithering.

Dithering is achieved by using the signal already present on D0 (the LSB on the data bus) as a noise source. C40 and C41 filter this noise source signal which is then applied to the signal from the pressure sensing interface.

Applying this dithering technique results in a noisy signal being sent to the A-D converter, this then results in a varying output which is digitally filtered and converted to the pressure units being displayed. The end result is that the resolution of the ADC is improved.

Motor interface

The stepper motor is controlled by a sequence of pulses supplied from the main processor.

A common ENABLE_MOTOR signal (see *Figure 4.4*) and one of the four motor control lines are fed to each AND gate. When the ENABLE_MOTOR signal is high, a pulse on one of the motor control lines will cause one of the four power mosfet's to be switched on, and the resulting output pulses are used to drive the stepper motor.

The ENABLE_MOTOR signal is pulled low by the microprocessor supervisor chip IC15, when the chip detects a watchdog timeout. R35 and R36 enable the main processor to detect current flow through Q19 or Q20 (MOTORSENSE1) and Q21 or Q22 (MOTORSENSE0).

C26 and C27 remove any voltage spikes which may occur.

R7C and R7D are current-limiting resistors.

The 'T' filters L6, L7, L8, and L9 are for electro static discharge protection of the motor interface. The diodes provide a path for the charge stored in the motor coils when the transistors are switched off.

Power control

IC2 (see *Figure 4.5*) acts a linear regulator in order to provide a 5 V DC supply (Vcc) for the logic circuits.

C11, C12 and C13 are decoupling capacitors.

IC3B and IC3C form a set/reset latch to operate the power MOSFET Q4. The latch is triggered by a high pulse from the main processor (OFF), causing Q4 to turn off and disconnect the power. Once tripped, the latch cannot be reset by the processor, but must be reset by a high pulse from the keyboard **ON** button.

Q6, R28 and R29 form a logic level translator to shift 0 to 5 V logic levels into 0 to 7 V logic levels for IC3, which has a permanent 7 V DC supply.

C14, C10, and R30 overcome the effects of any transients.

D5 prevents C10 from discharging into IC3B in the event of Vdd being removed.

The Vacuum Fluorescent Display (VFD) has its own independent voltage regulation circuit. With Q7 switched on Vin will be applied to IC4, a high current 5V voltage regulator. The output of IC4 is used to power the VFD.

The circuit comprising R23, R24, C9, bandgap references D4 and D30, and transistor Q5, supplies a constant voltage (Vcc') of approximately 3 V DC.

The supervisor chip transfers the power for the real time clock and RAM from the regulated 5 V DC supply, Vcc, to Vcc' when the main power, and hence Vcc, is turned off. This preserves any memory held in RAM and keeps the real time clock running.

LED D6 is illuminated when a voltage is present on Vac. This signifies that the AC supply is connected to the pump.

Sensors interface

The seven opto-sensors are split into three groups (see *Figure 4.6*) and these three groups are multiplexed onto three lines into the microprocessor.

The three groups are used as follows:

- One group is used by the size sensor board.
- The second group monitors whether the pump's plunger clamp is open or closed, whether the slotted disc used in the occlusion sensing system is rotating and whether the nearly empty flag has entered the opto-sensing slot.
- The third group has only one member, which is used to signify whether a pressure sensing disc has been inserted into the pump.

Q3 activates the size sensor LEDs, Q1 activates the status sensors LEDs and Q18 activates the disc detector LED. The three transistors are activated independently and should not be active at the same time.

R4, R5, R8, R9, R81 and R82 are current limiting resistors.

On the detection side of the opto-detectors, R77, R78 and R79 are pull up resistors. R6A, B, C, D, R7A and R7B are current limiting resistors. Zener diodes D1, D2 and D3 are used for electrostatic discharge protection.

When a photo transistor detects the LED associated with it, the line OPTO_0,1 or 2, will be pulled low. This signal is then input to the microprocessor via SENSE3, 4, or 5.

R1, R2, and C1 make up the low battery voltage sensing circuit. R1 and R2 act as a potential divider enabling the voltage between them to be input to the A-to-D converter of the main processor.

The pressure sensing interface circuit (see *Figure 4.7*) consists of an instrumentation amplifier with an adjustable offset. The Tee filters L3 and L4 along with C3, C4, R17 and R18 are for electrostatic discharge protection.

IC1A, B and C with associated components R12 to R16, R19, R20, C5 and C6 make up the instrumentation amplifier.

IC1D is a voltage follower and allows the processor to detect a signal on one of the inputs to the instrumentation amplifier. R11 is a pull up resistor for op-amp IC1A.

OFFSET_TRIM (see *Figure 4.7*) is a PWM output signal from the processor and this signal is attenuated by the potential divider R21 and R22. C42 smooths the PWM output to a DC level. This DC signal is applied to the relevant stage of the instrumentation amplifier, so that when the pressure sensor is being calibrated the zero mmHg calibration point will be equivalent to 0.5 V, and this voltage appears at the PRESSURE output.

This PWM signal will remain constant until the transducer is next calibrated.

Each time the pressure sensing disc is inserted, or the pump is switched on, an auto zero is carried out. This allows the zero pressure voltage to differ by up to ± 0.5 V of the calibrated zero point.

If the voltage is outside these limits the pump will issue a warning and must be re-calibrated. So the voltage on the PRESSURE output line will normally be between 0 and 1.0 V, and exactly 0.5 V immediately after a calibration routine.

IC1D is a voltage follower and allows the processor to detect a signal on one of the inputs to the instrumentation amplifier.

RS232 serial interface

WARNING

Only items of equipment that conform to EN60950 may be connected to the 9-pin RS232 connector that is situated at the rear of the pump. This conformity prevents the safety of the patient being compromised.

The micro controller generates an RS232 compatible signal with a 0 to 5 V output. IC5, with ancillary components L5, R33, C18, C19, C20, C21, and C22 converts the 0 to 5 V signal to a +/-10 V output. IC7 is supplied with a single +5 V power rail and uses two charge pumps to create a 10 V and -10 V supply. R34 A, B, C and D are for electrostatic protection.

The signals on the D connector are shown on *Figure 4.18*, and the pin connections for the D connector are shown on *Table 4.1*.

Table 4.1 RS232 D connector

Pin No.	Connection
1	Not connected
2	RxD
3	TxD
4	Not connected
5	GND
6	DSR (handshake out)
7	RTS (+10 V out)
8	CTS (handshake in)
9	Not connected

Umbilical connector

The umbilical ribbon cable connector (see *Figure 4.9*) enables data and the circuit power supplies to be sent between the main circuit board (front case) and the umbilical board on the rear case.

Input/output serial interface

The processor communicates with its input and output devices with a serial-in and a serial-out line.

The serial data, MOSI, is converted to a parallel output by three shift registers, IC 8, 9 and 10. The parallel outputs are used to power the various LEDs and control the keyboard driving sequence. The keyboard input along with the mains present signal is converted to the serial signal, MISO, by a parallel input serial output shift register, IC11.

ICs 8 and 9 are linked so that they appear to work as a single 16 bit output serial input shift register. The signal MOSI is common to IC8 and IC10.

The FPSEL1 and FPSEL2 lines define whether to activate ICs 8 and 9 or ICs 10 and 11.

The SCLK clock signal is fed to all four ICs.

The pump's front panel input device consists of 11 press-buttons. The **ON** button when pressed completes the circuit between pins 1 and 2 on PL3.

The remaining keys use a 3 x 4 matrix. The four lines on PL3 pins 6 to 9 inclusive are pulled high by resistor R70A, and are connected to IC11. Each line is connected to one of the 4 rows of the keyboard matrix.

The 3 columns of the matrix, PL3 pins 3 to 5 are connected to IC8, the parallel out serial shift register. As each individual column is pulled low the status of each key in that column is input to IC11.

Resistor R66 limits the current in the control lines out of IC8. The diodes D11 to D13 allow IC8 to pull the required control line low but let the remaining lines float when a logic high is applied at the output of IC8.

Zener diodes D22 to D24 inclusive and quad resistor packs R73 and R74 form the electrostatic discharge protection circuit.

(contd.)

The remaining five output lines on IC8 are used to activate transistors Q9 to Q13 inclusive, and these transistors control the illumination of the syringe size indication LEDs, D17 to D21.

The outputs from IC9 are used to control which group of opto-sensors are activated and also to activate transistors Q14, Q15, and Q16: these transistors control the illumination of the **ALARM**, **START** and **STOP** LEDs. Resistors R52 to R57 inclusive are current limiters.

The display is a 20 character, two line Vacuum Fluorescent Display (VFD) that is linked to the main board by PL5.

The display data is transmitted via MOSI to IC10, which is enabled by FPSEL2. The output of IC10 is input to the VFD by a signal from VFDSTB, when the VFD_BUSY signal signifies to the processor that the VFD is ready to accept the next byte of data.

The supervisor chip IC15 can turn on the sounder independently of the microprocessor via ENABLE_MOTOR. This independence occurs if the processor malfunctions and is unable to produce its own sounder control; in which case the supervisor chip's watchdog would timeout thus generating an ENABLE_MOTOR control.

D28 prevents a low signal from SOUND drawing a current from IC15. Q8 and associated components C30, R39, R40 and R41 constitute a low-pass filter which allows the PWM signal SOUND from the micro-controller to activate the sounder. The sounder is connected to PL2.

R3, R10, R76, C2 and Q2 enable the main processor to detect the presence or absence of mains power. When mains power is present a low signal is applied to pin 14 of IC11. This signal is then transmitted serially to the processor via MISO.

Regulator board

The pump utilizes a primary switching power supply (see *Figure 4.11*).

The advantages of this type of supply over a conventional secondary switching power supply include the following:

- greater efficiency,
- larger power capability for a given size of supply, and
- a smaller transformer is needed for the equivalent power.

The regulator circuit is based on a universal input switch-mode controller, IC1 (see *Figure 4.12*). IC1 uses a current mode, pulse width modulation control circuit, which allows it to operate over a wide range of AC input voltages i.e. from at least 90 V to 270 V AC.

The regulator also provides a 7 V DC supply for the motor and the LEDs. This supply is then used to provide a 5 V DC supply for the logic circuits

The regulator circuit is protected by a mains fuse, FS2. The mains supply is then filtered by C14 and L2. R20 allows the residual charge on C14 to be dissipated when the pump is removed from the mains supply.

The output from the bridge rectifier D7 is smoothed by C10 and transient current limited by varistor V1. When V1 is cold, the resistance is high and current is limited. As the thermistor warms up, the resistance decreases, allowing the current to increase. The output from VR1 is used to start up IC1 via pin 1. It is also fed to the primary winding, pin 6 on the power transformer.

Once the switch-mode controller has started working, it obtains its power supply from a bootstrap winding on pins 2 and 3 on the transformer. The power supply from the bootstrap winding is rectified by diode D5, smoothed by C13 and regulated by the Zener diode D6.

The PWM signal output from pin 5 on IC1 controls the operation of Q3 causing it to cycle on and off and regulate the flow of current from D7 through the primary winding. C1 and R1, C2 and R2, C3 and R4, C4 and R3 are all transient suppression circuits.

The voltage on pin 12 (IN1) of the secondary winding is rectified by diodes D1 and D3 (see *Figure 4.13*). The output from D1 is then smoothed by C6 and passed to pin 4 of PL11.

The DC output from D3 is filtered by C5, C7 and L1. The link to PL11 pin 3 is protected by a 1 amp fuse, FS1.

When the mains supply is being used there is a voltage present on pin 4 of PL11. By using R6 and R7 as a potential divider, this voltage is used to control Q2.

When there is no mains supply, Q2 is not active and so prevents the batteries from discharging through R8, R9, RV1 and R10.

When Q2 is activated, R8, TH1, R9, RV1 and R10 form a potential divider between the output of D3 and 0 V. The output from this is used as the reference voltage for the adjustable precision shunt regulator D4. Capacitor C8 is a transient suppressor.

Thermistor TH1 varies the reference voltage according to temperature, thus compensating for battery charging characteristics.

The feedback process occurs when the voltage at the wiper of RV1 exceeds the reference value, D4 conducts and activates the opto-coupler IC2. The current through its photo-transistor causes a voltage to be developed across resistor R19. This voltage is applied to IC1 which changes the mark-space ratio of the output signal on pin 5.

An over voltage situation resulting from a malfunction in the regulator is prevented by a crowbar protection device. When the output voltage exceeds 13 V, the Zener diode D2 conducts. This causes a voltage to be developed across R5. This voltage is used to activate the silicon controlled rectifier Q1 which will sink enough current to result in fuse FS1 blowing.

PL 11 output

See *Table 4.2* for the plug PL11 connections.

Table 4.2 PL11 connections

Pin	Output
1/2	Ground
3	7 V DC when on mains or battery supply
4	7 V DC when on mains supply

PL12 output

PL12 provides a link to the rechargeable batteries and the link is protected by FS3 a 2 amp fuse.

Setting RV1

The procedure for setting potentiometer RV1 is as follows:

1. Switch off the external AC power, remove the pump's power connector and open the casing (see page 2-11).

2. Remove plug PL11 and PL12 from the Regulator board and connect a 68 ohm, 1 watt resistive load across pins 2 and 3 of plug PL11. Pins 2 and 3 are the two middle pins on the connector.

   Note:
   A Molex connector (*part number 0053-0658*) enables the 68 ohm resistor to be easily connected to the pins of PL11.

WARNING

Only a qualified technician may carry out the following procedures. With the case open, dangerous voltages are present when AC power is applied.

3. Connect and switch **ON** the AC power. If necessary, adjust RV1 to give a DC voltage across the 68 ohm load, dependent on the temperature, as shown in Table 4.3. RV1 is located near the bottom left hand corner of the board (see *Figure 7.8*).

Table 4.3 Temperature/voltage range for setting RV1

Ambient temp. (deg. C)	Voltage across load (volts)
28	7.015
27	7.027
26	7.038
25	7.050
24	7.062
23	7.073
22	7.085
21	7.096
20	7.108
19	7.120
18	7.131
17	7.143
16	7.154
15	7.166

4. Switch off the AC power. Remove the 68 ohm load and reconnect PL11 and PL12 to the Regulator board. Assemble the casing (see page 2-11).

Syringe size sensors

The syringe size sensors board is physically located at the centre of the lower casing. The circuit diagram for these sensors is shown in *Figure 4.14*. The layout of the components are shown in *Figure 7.6*.

Status sensors

The status sensors board is physically located on the left hand side of the lower casing. The circuit diagram for these sensors is shown in *Figure 4.15*. The layout of the components are shown in *Figure 7.5*.

Distribution board

The Distribution board routes data between each individual board and also to the umbilical cable that connects to the Main board.

The Distribution board sits on a tray. The board and tray are situated in the lower casing of the pump. There are seven plugs situated on the board - PL1 to PL7.

The wiring to the plugs is shown in *Figure 4.16* and the layout of the connectors on the board in *Figure 7.10*.

Pressure sensing board

The ACAM pressure sensing board is situated in the concaved housing that is fixed to the extreme left hand side of the pump. A six-way connector is used to route the signals to the Distribution board.

The ACAM pressure sensing circuit is shown in *Figure 4.17*.

Main board components

The Main board is fixed to the pump's top casing and the components attached to the board are shown in *Figure 7.7*.

Regulator board components

The Regulator board is located on the right hand side of the lower casing and consists of a fused primary switching power supply. The component layout diagram is shown in *Figure 7.8*.

Membrane switch panel

The eleven buttons and the associated connections that make up the front membrane switch panel are shown in *Figure 4.18*.

'D' connector

The ribbon cable connections to the RS232 D connector are shown in *Figure 4.19*.

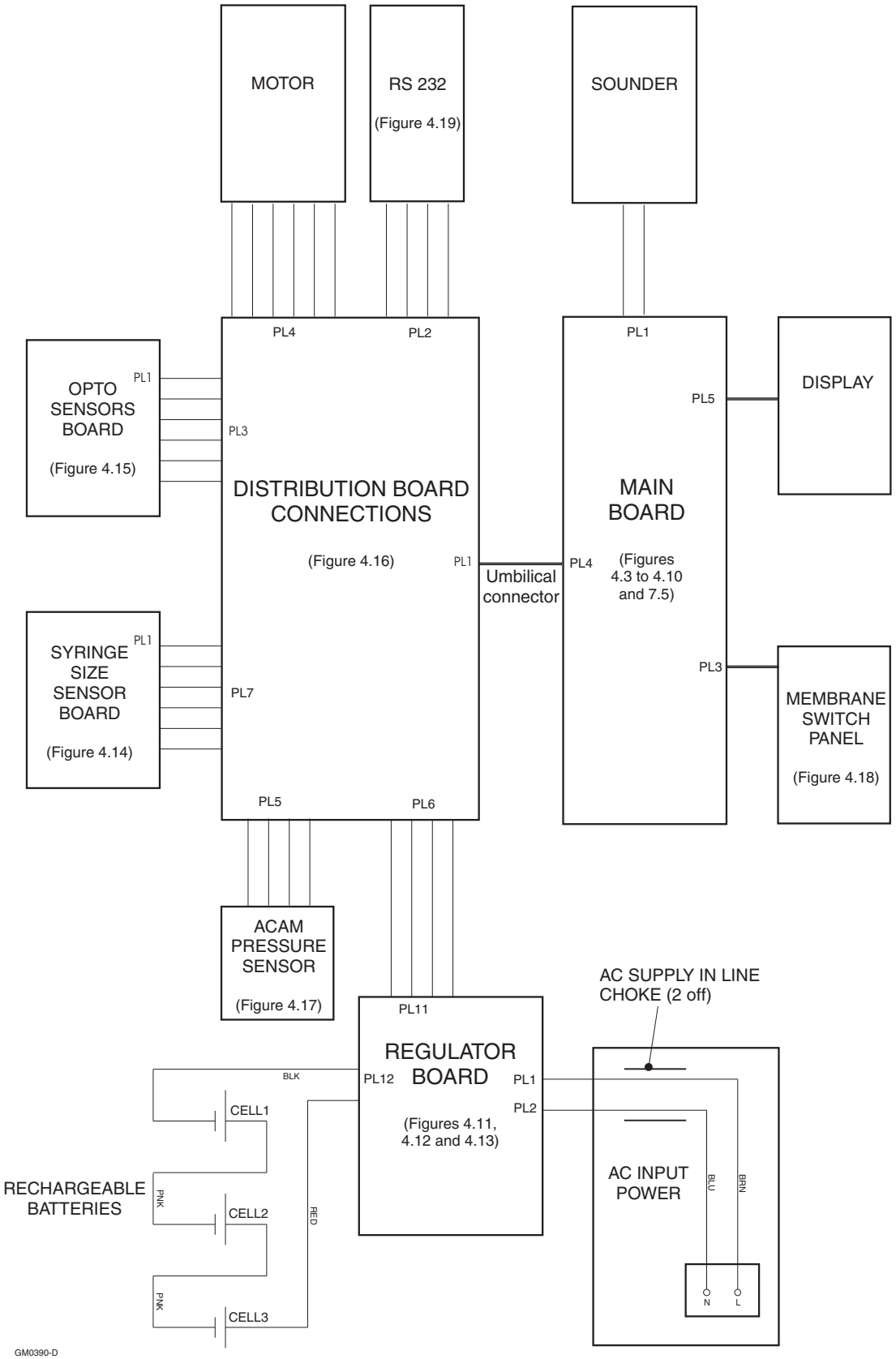


Figure 4.1 Overall block diagram of the 3200 system

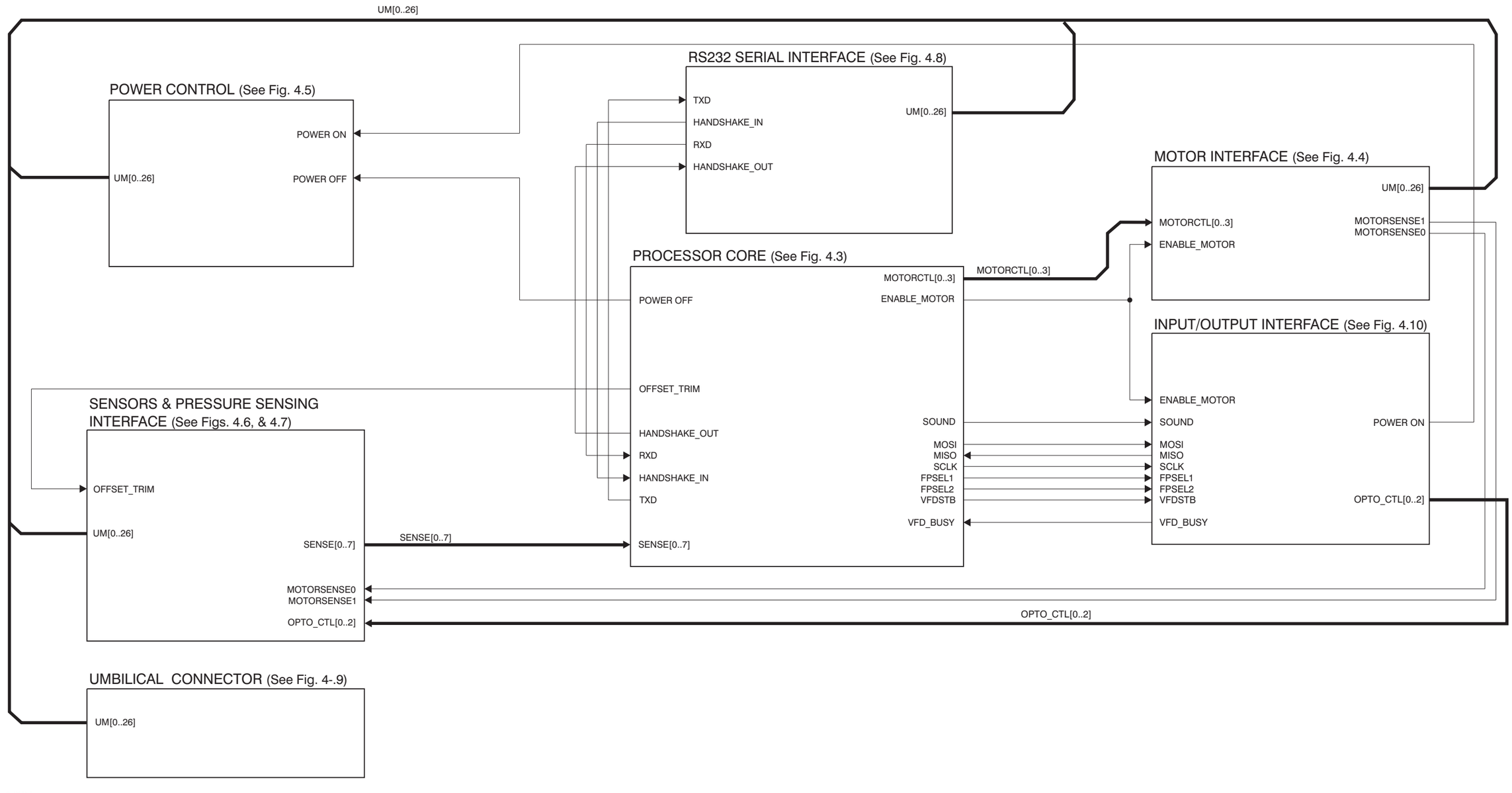


Figure 4.2 Main board block diagram

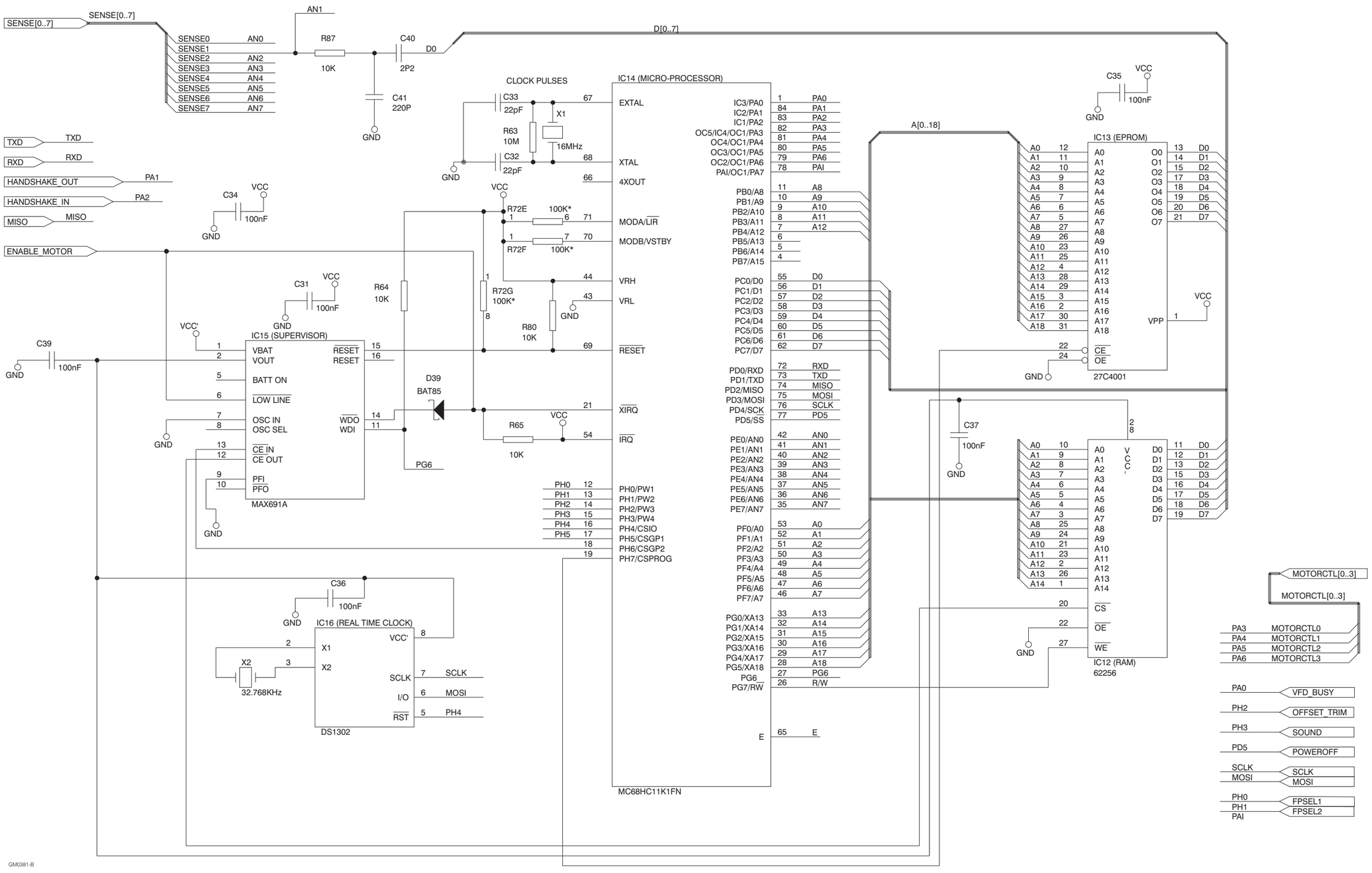


Figure 4.3 Processor core circuit diagram

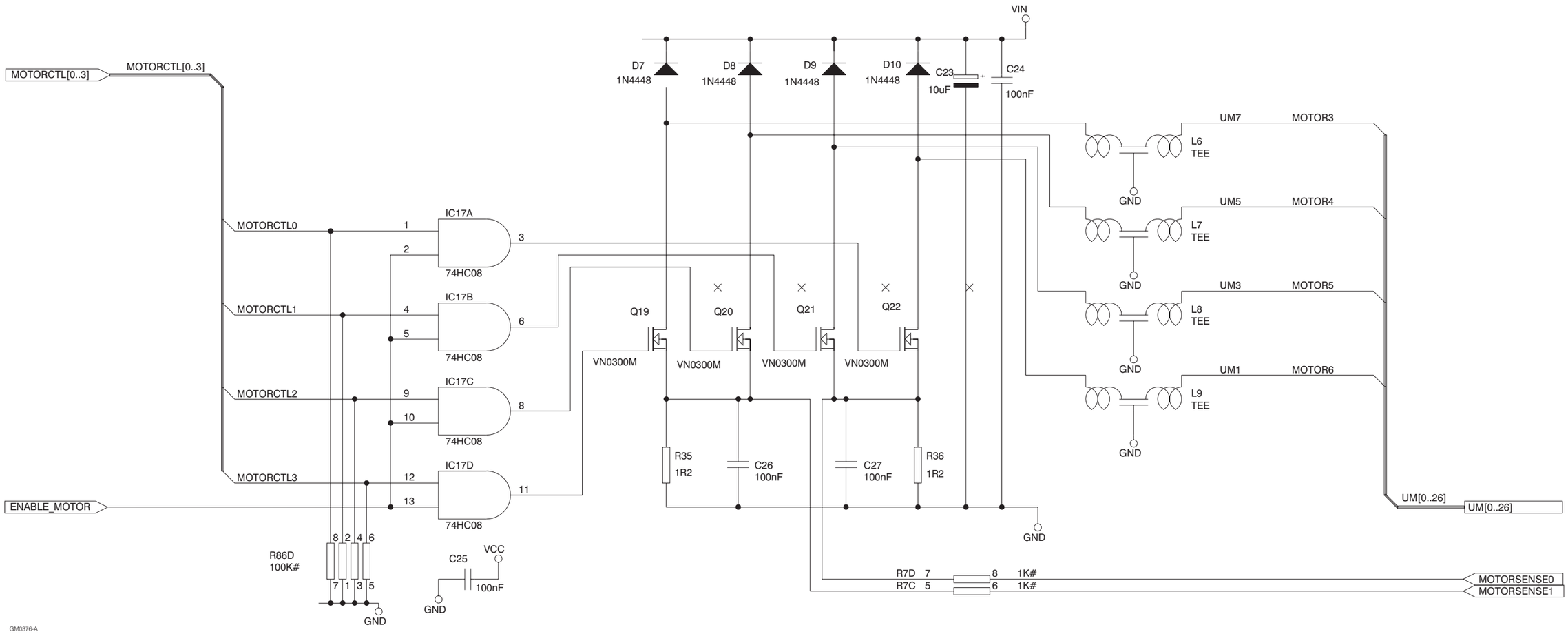


Figure 4.4 Motor interface circuit diagram

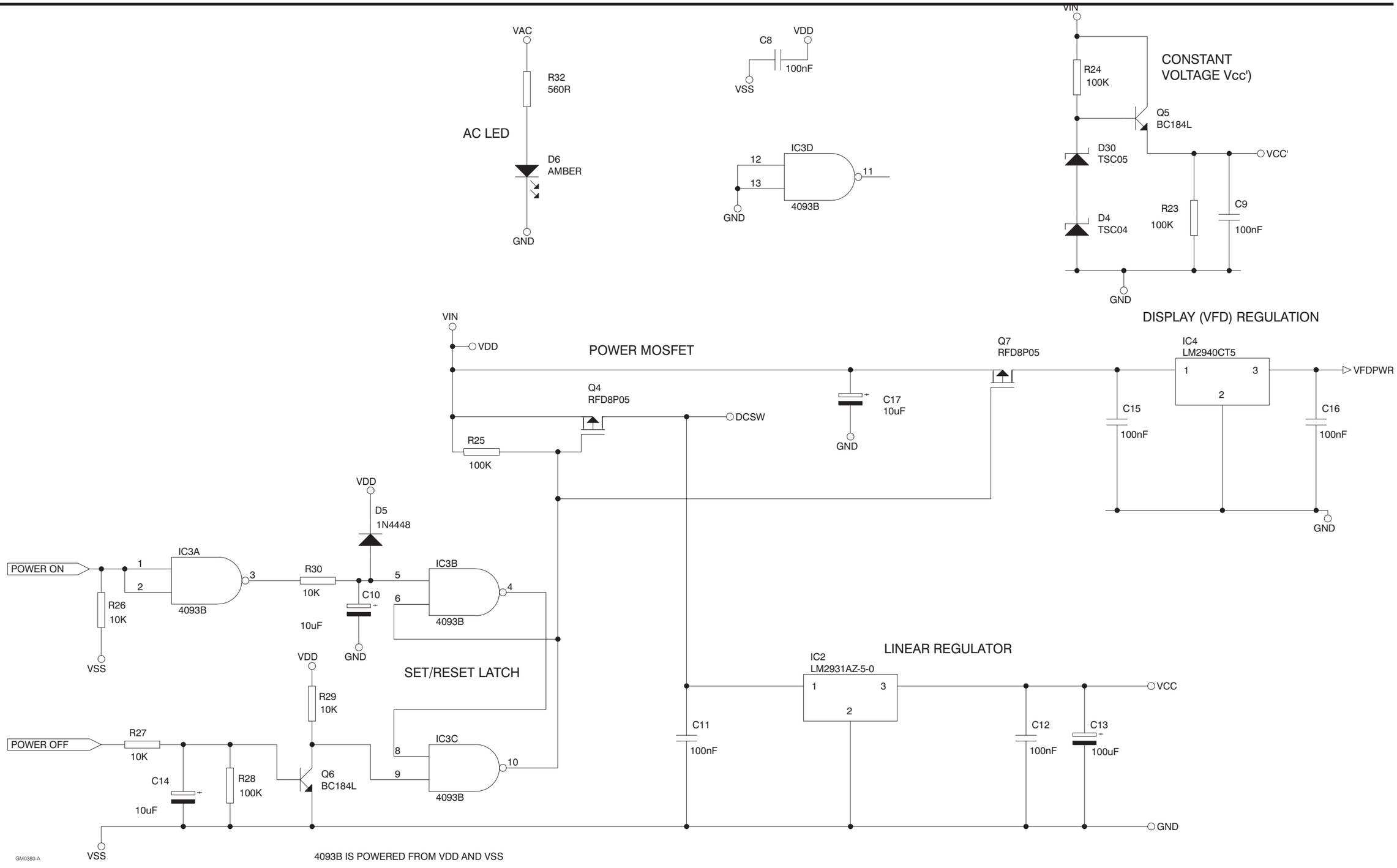


Figure 4.5 Power control circuit diagram

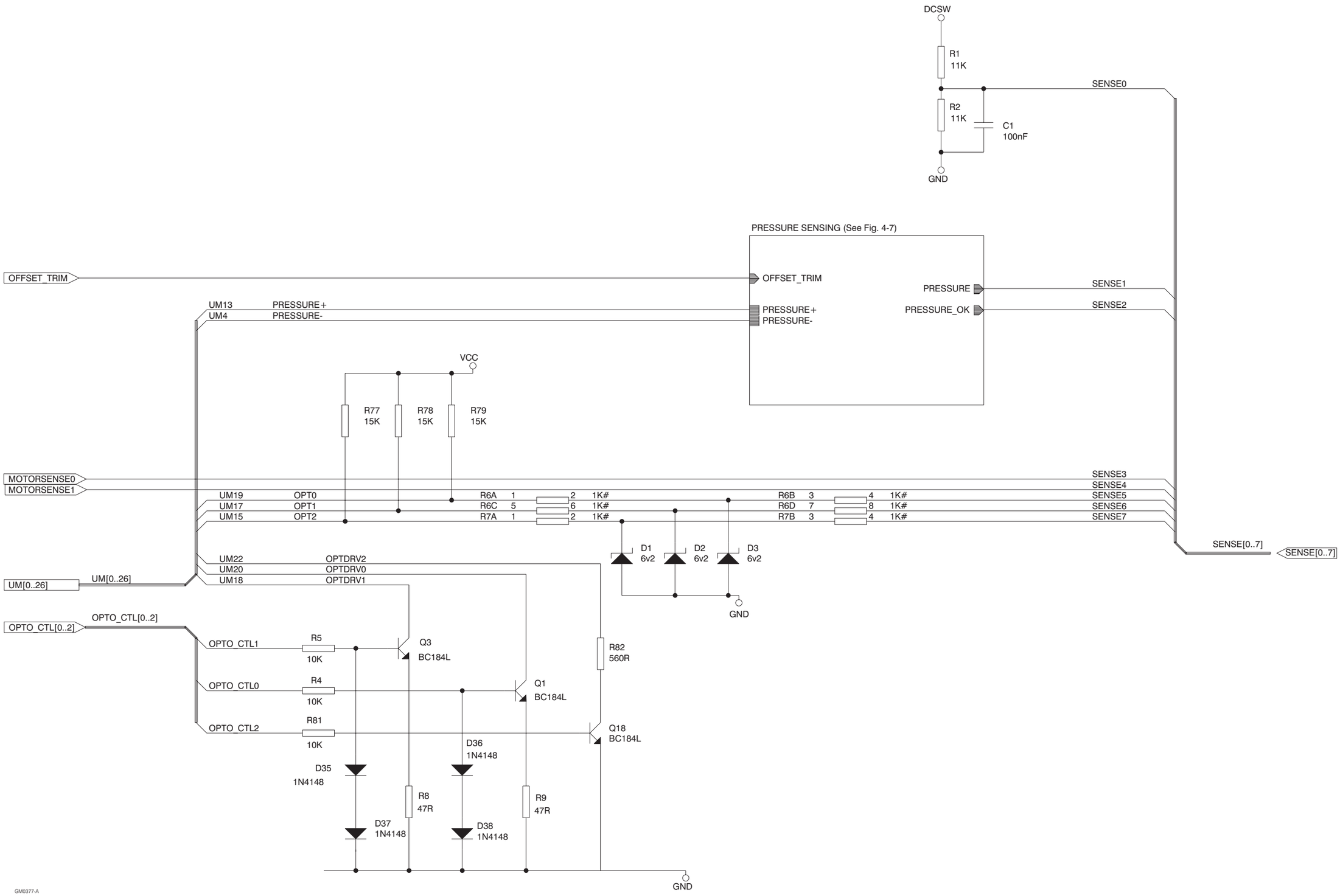


Figure 4.6 Sensors and pressure sensing interface

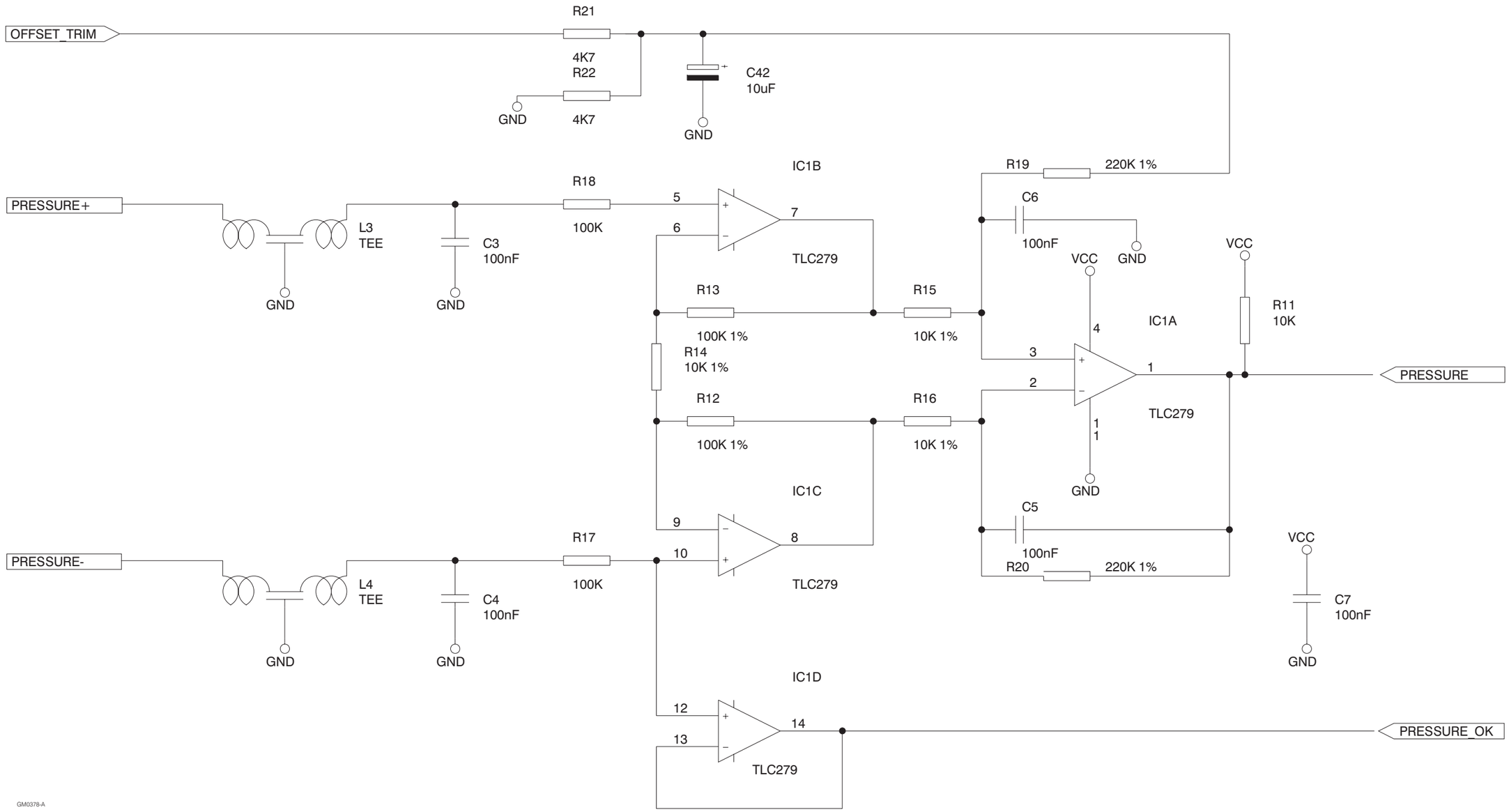


Figure 4.7 Pressure sensing interface circuit diagram

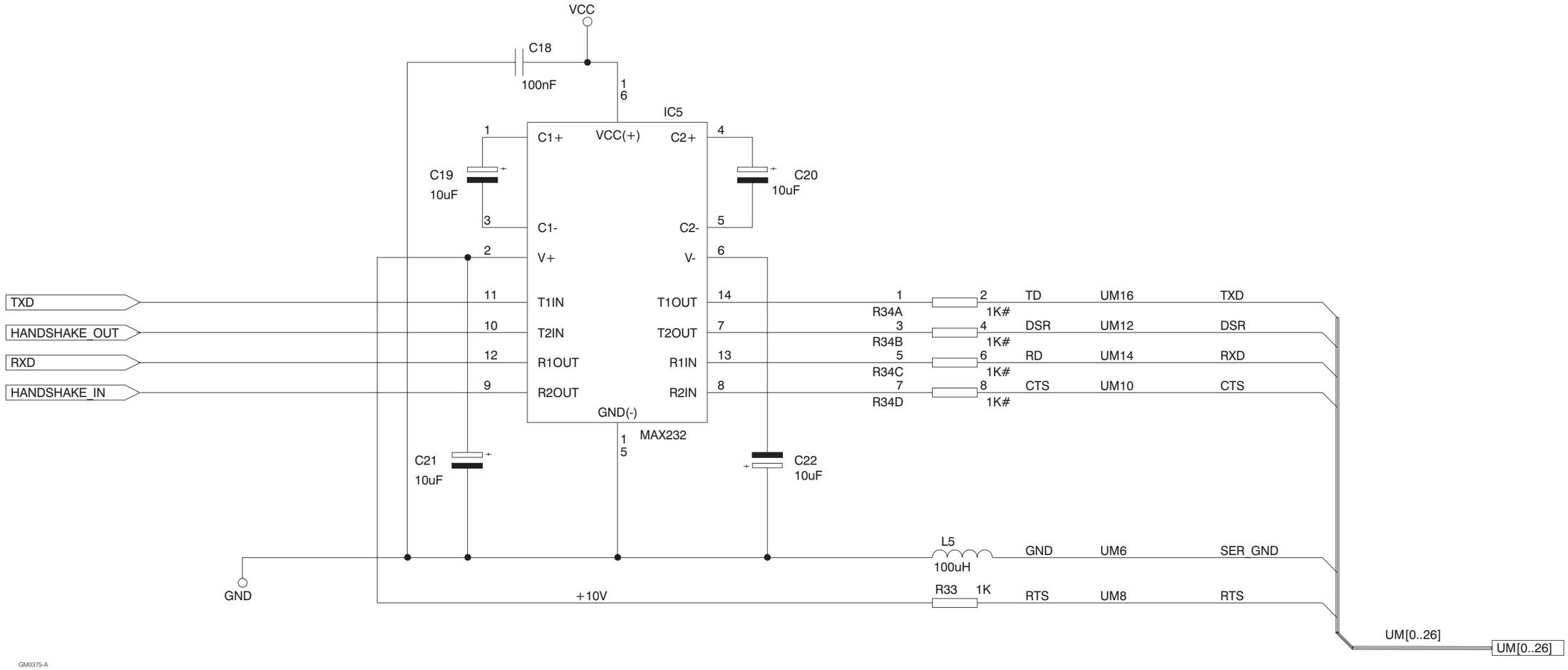


Figure 4.8 RS232 interface circuit diagram

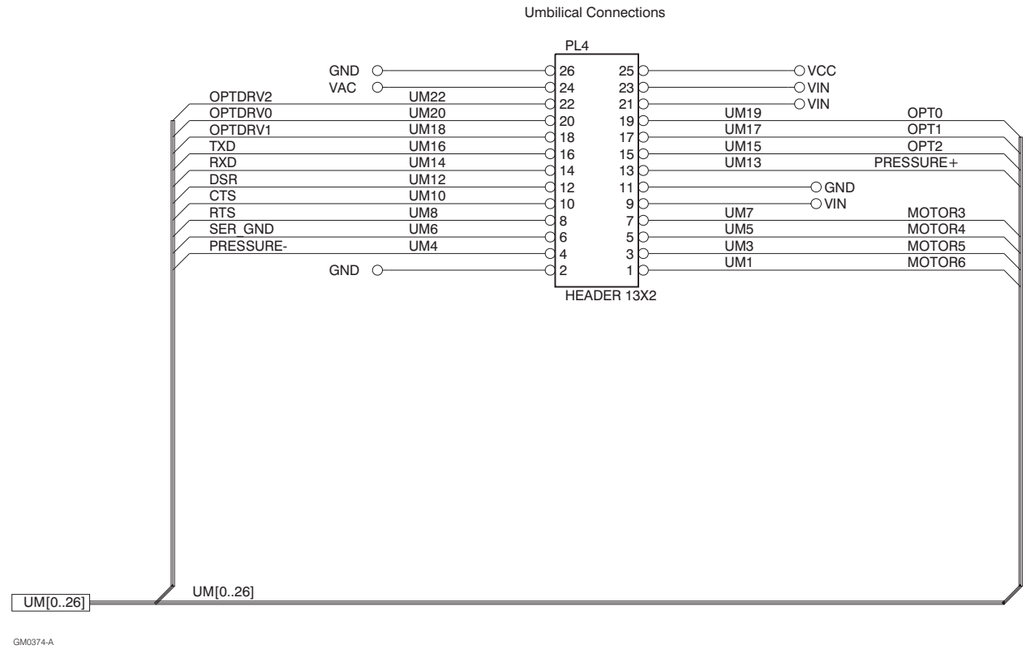


Figure 4.9 Umbilical cable connections

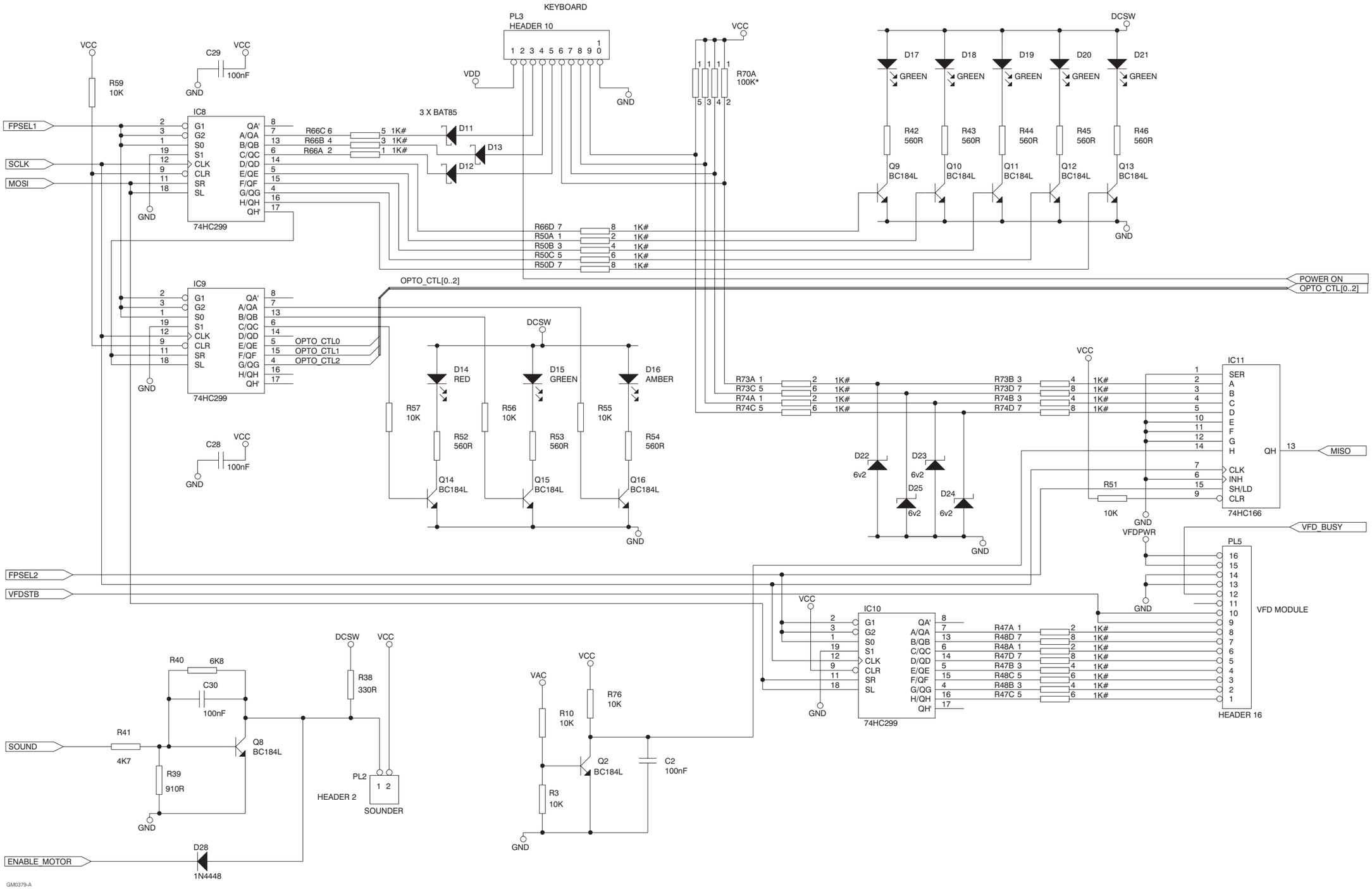


Figure 4.10 Input/output serial interface circuit diagram

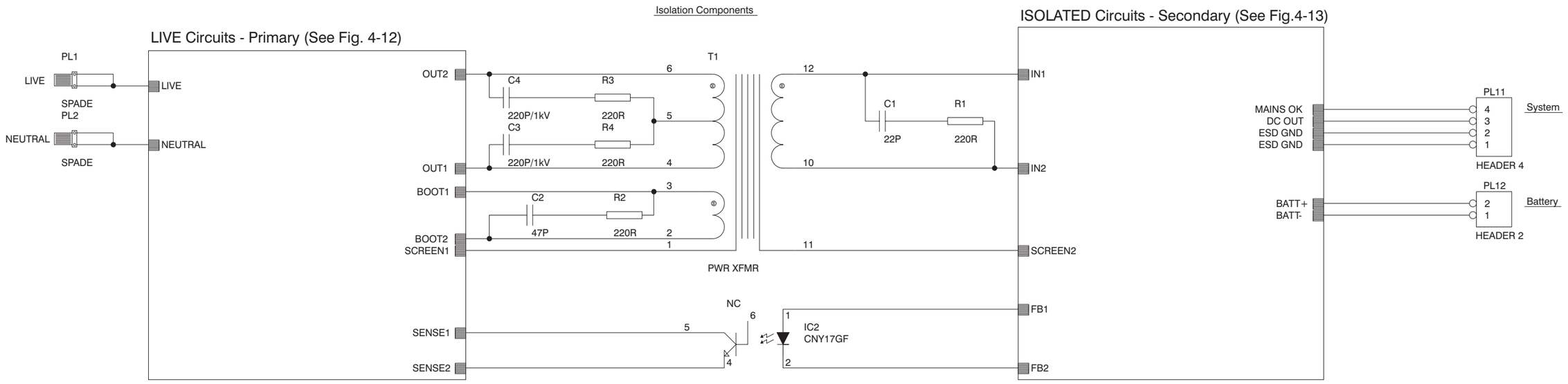


Figure 4.11 Overview of the regulator

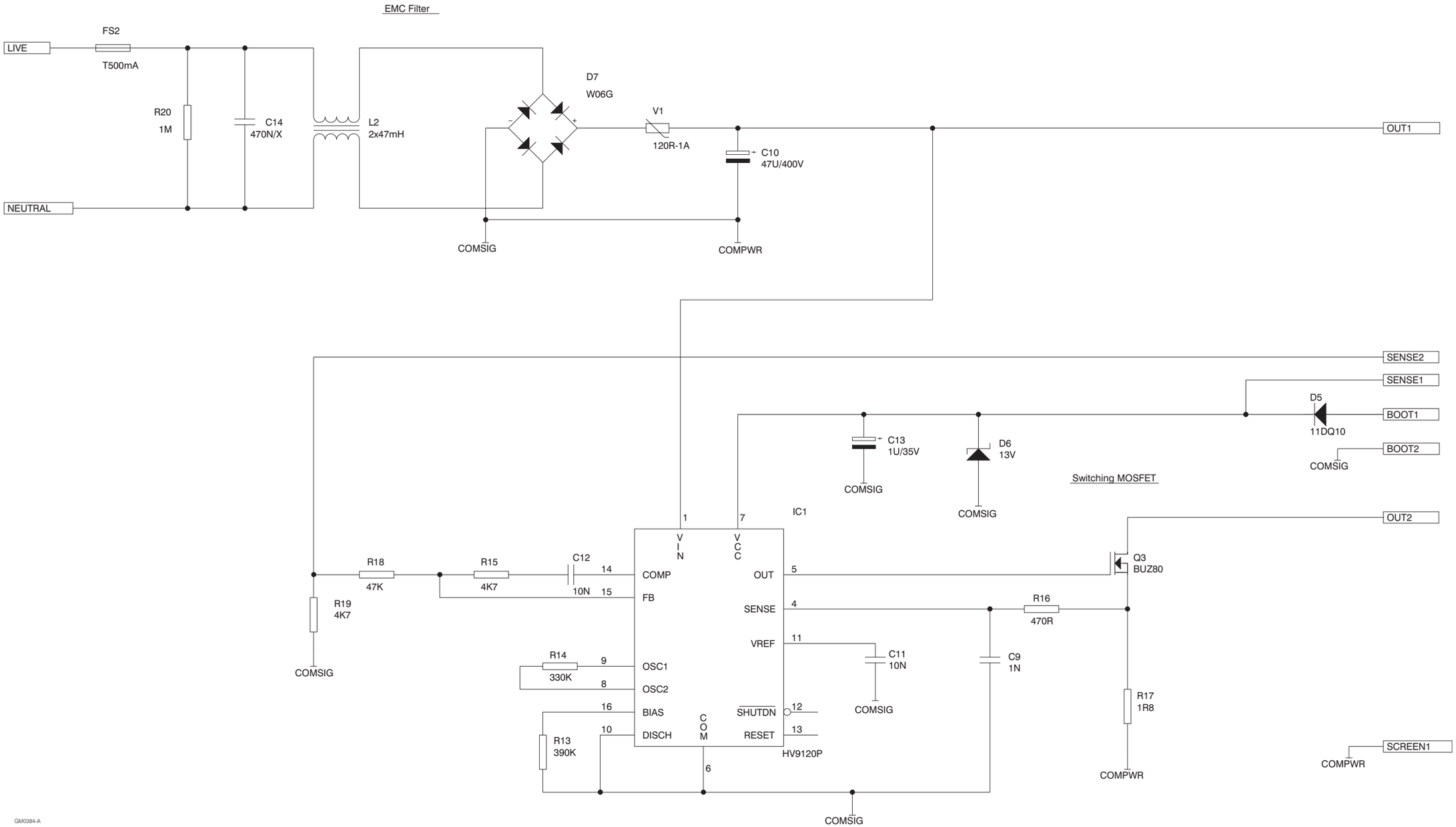


Figure 4.12 Regulator live (primary) circuit diagram

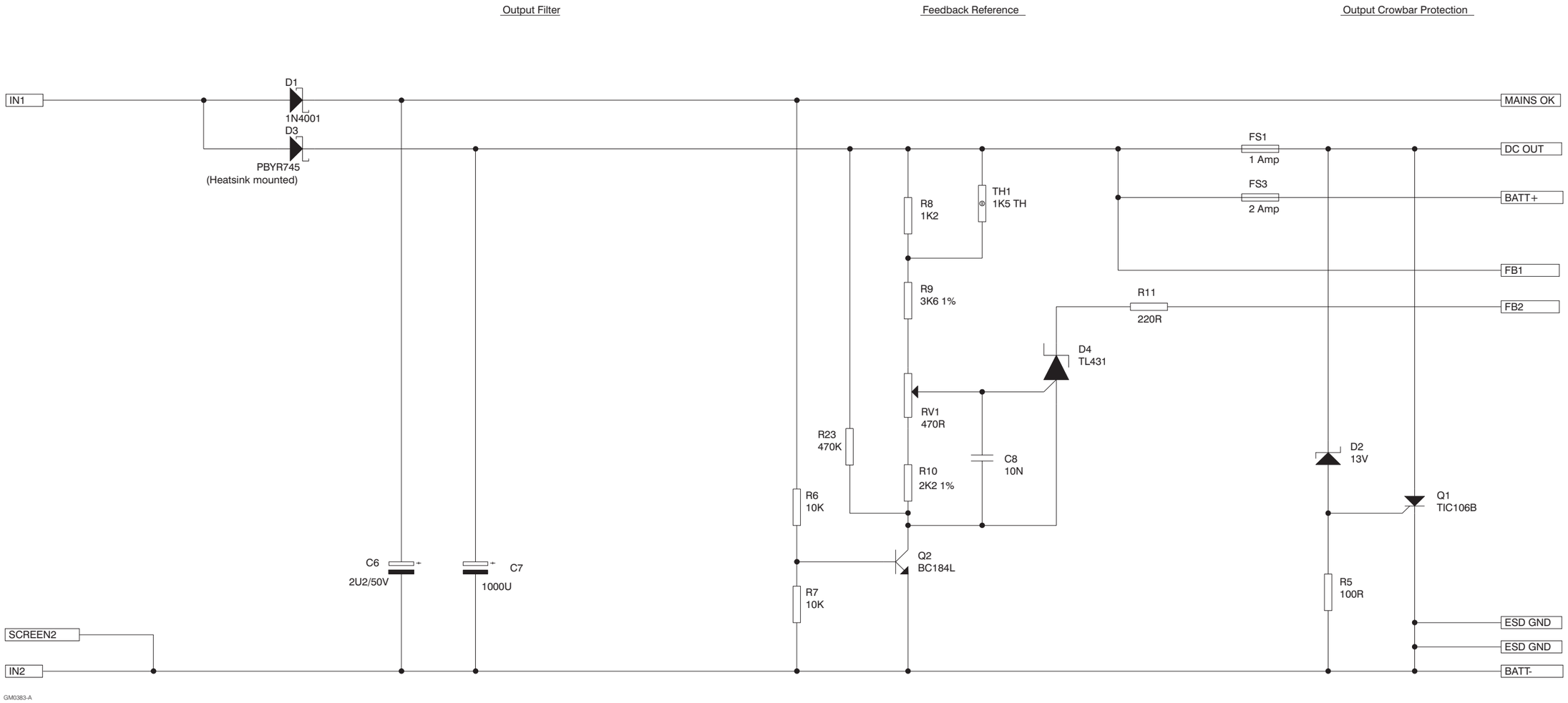


Figure 4.13 Regulator isolated (secondary) circuit diagram

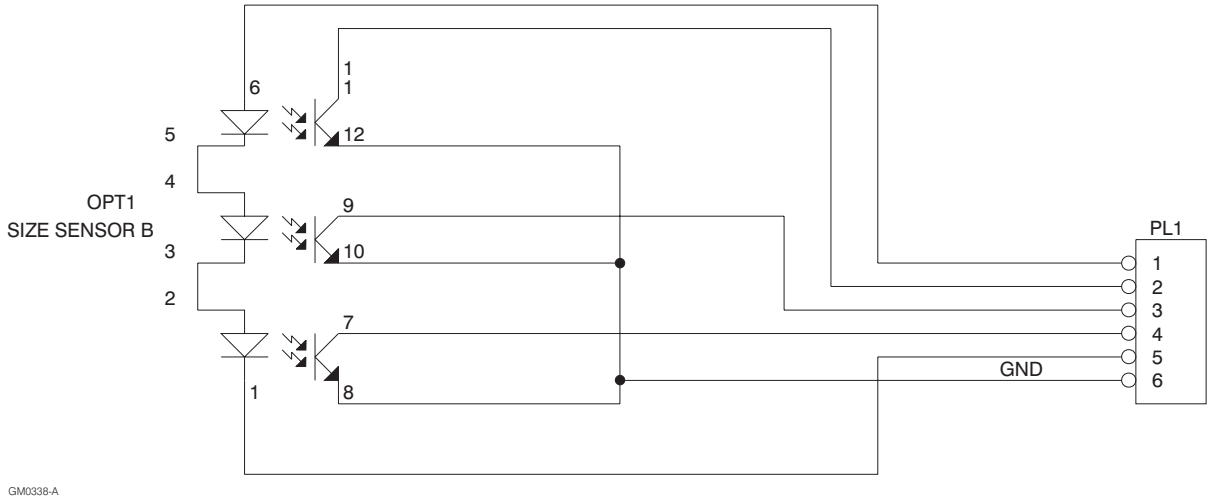


Figure 4.14 Syringe size sensors circuit diagram

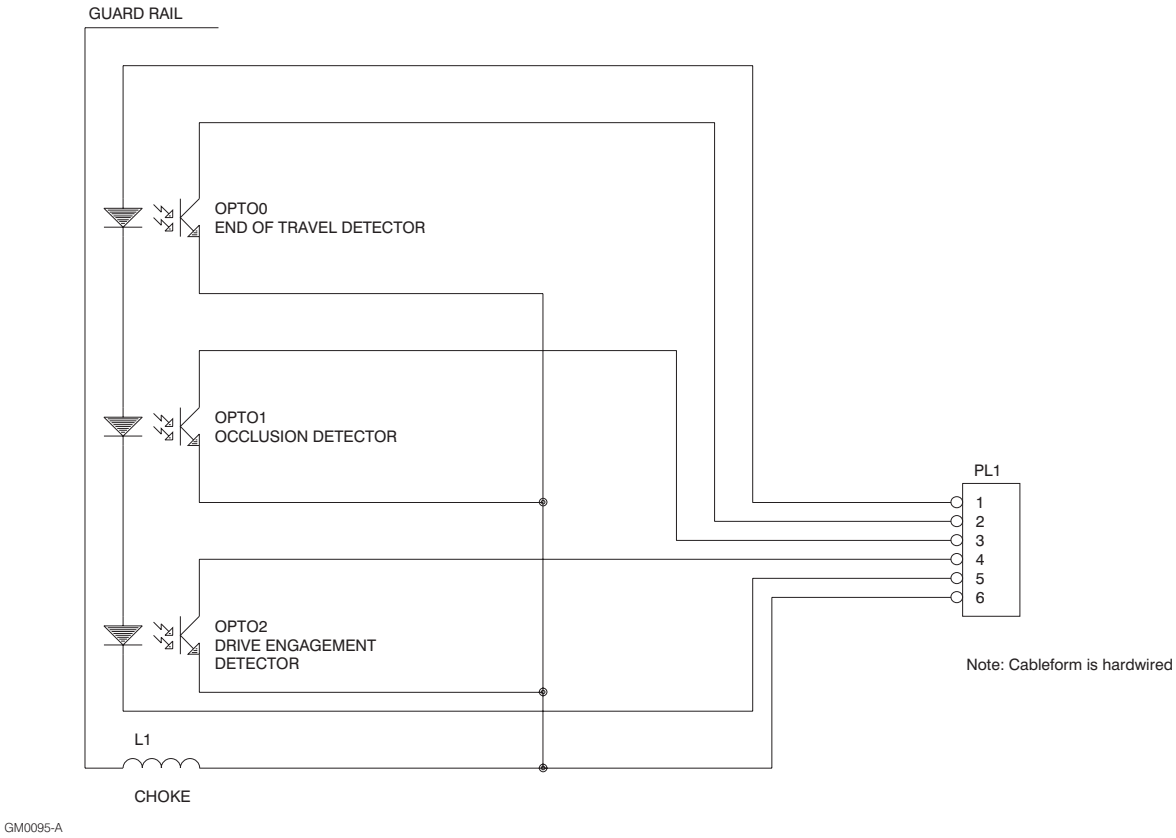


Figure 4.15 Status sensors circuit diagram

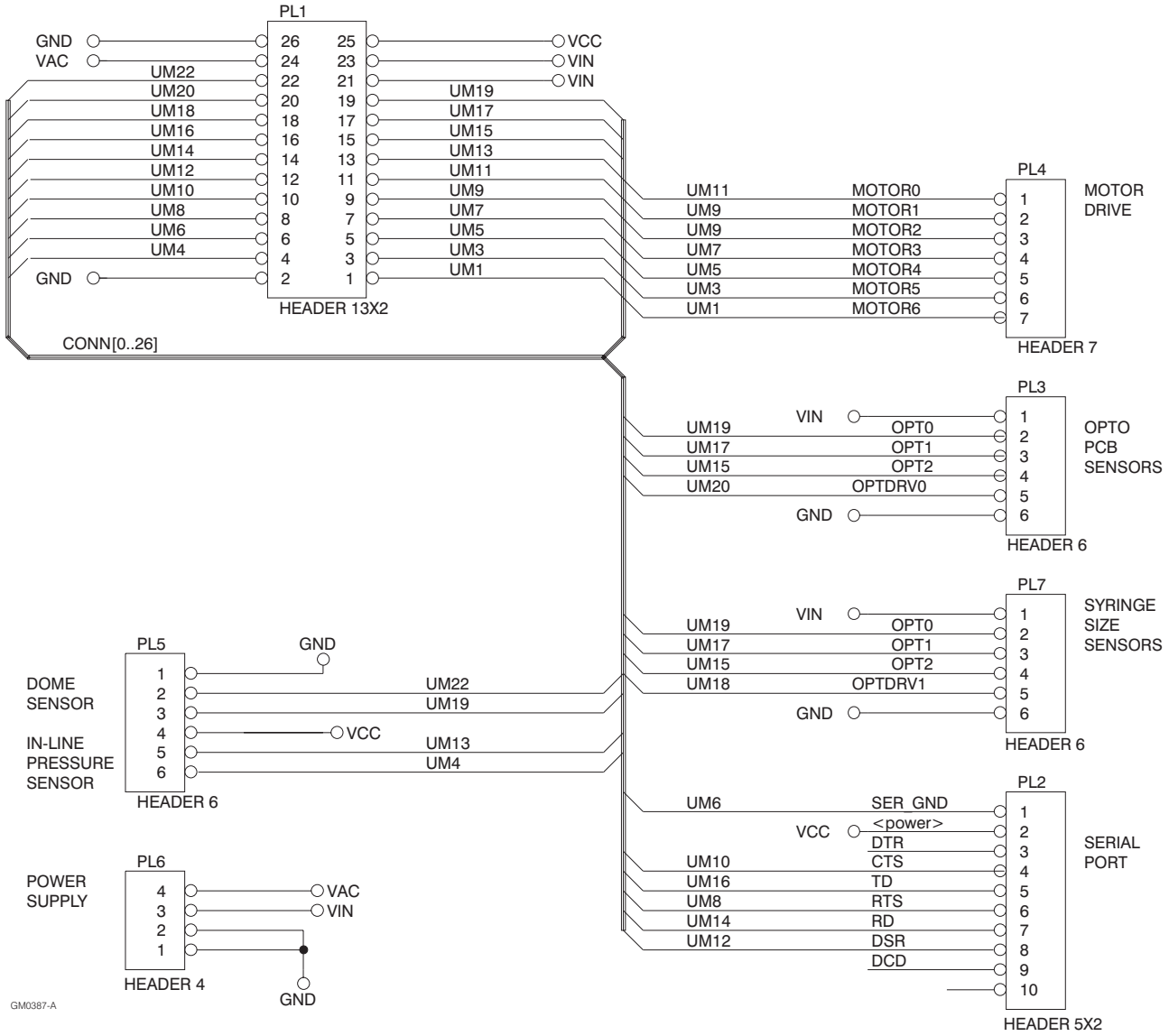


Figure 4.16 Distribution board connections

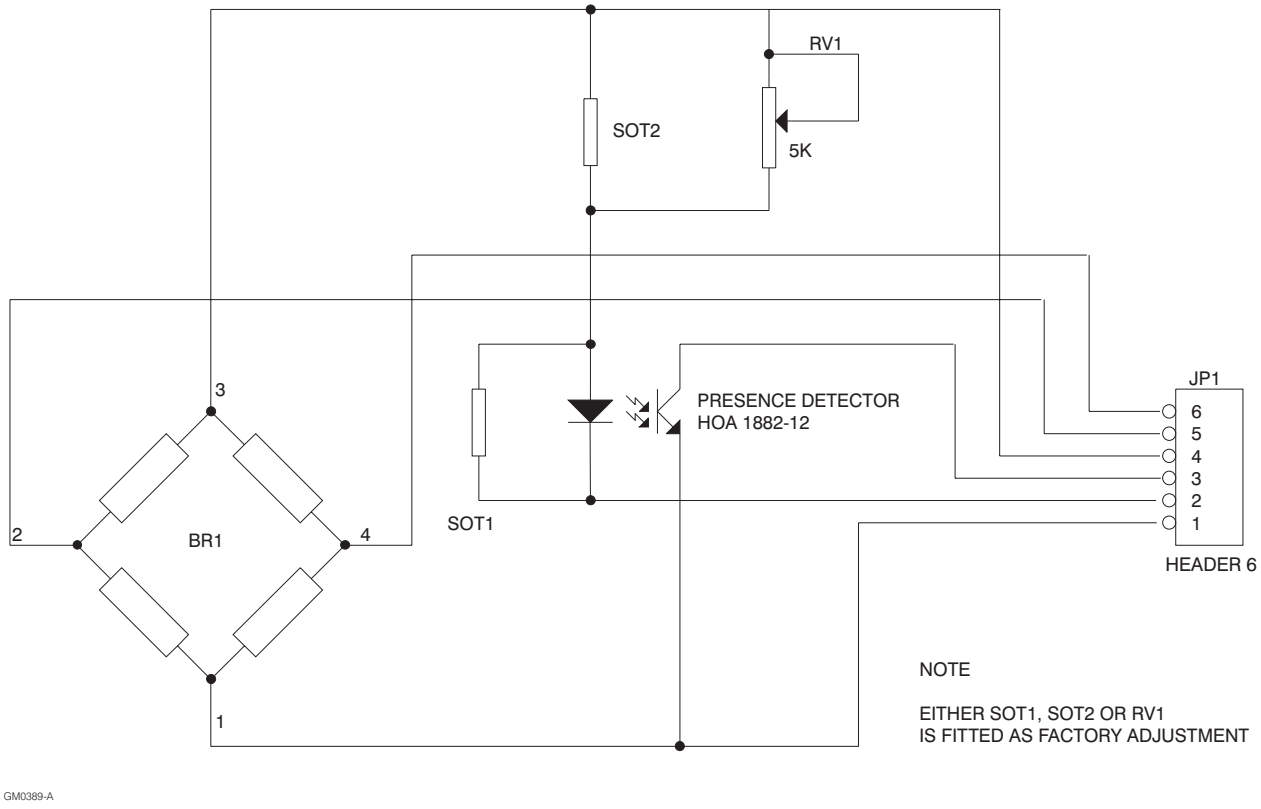


Figure 4.17 Pressure sensing circuit diagram

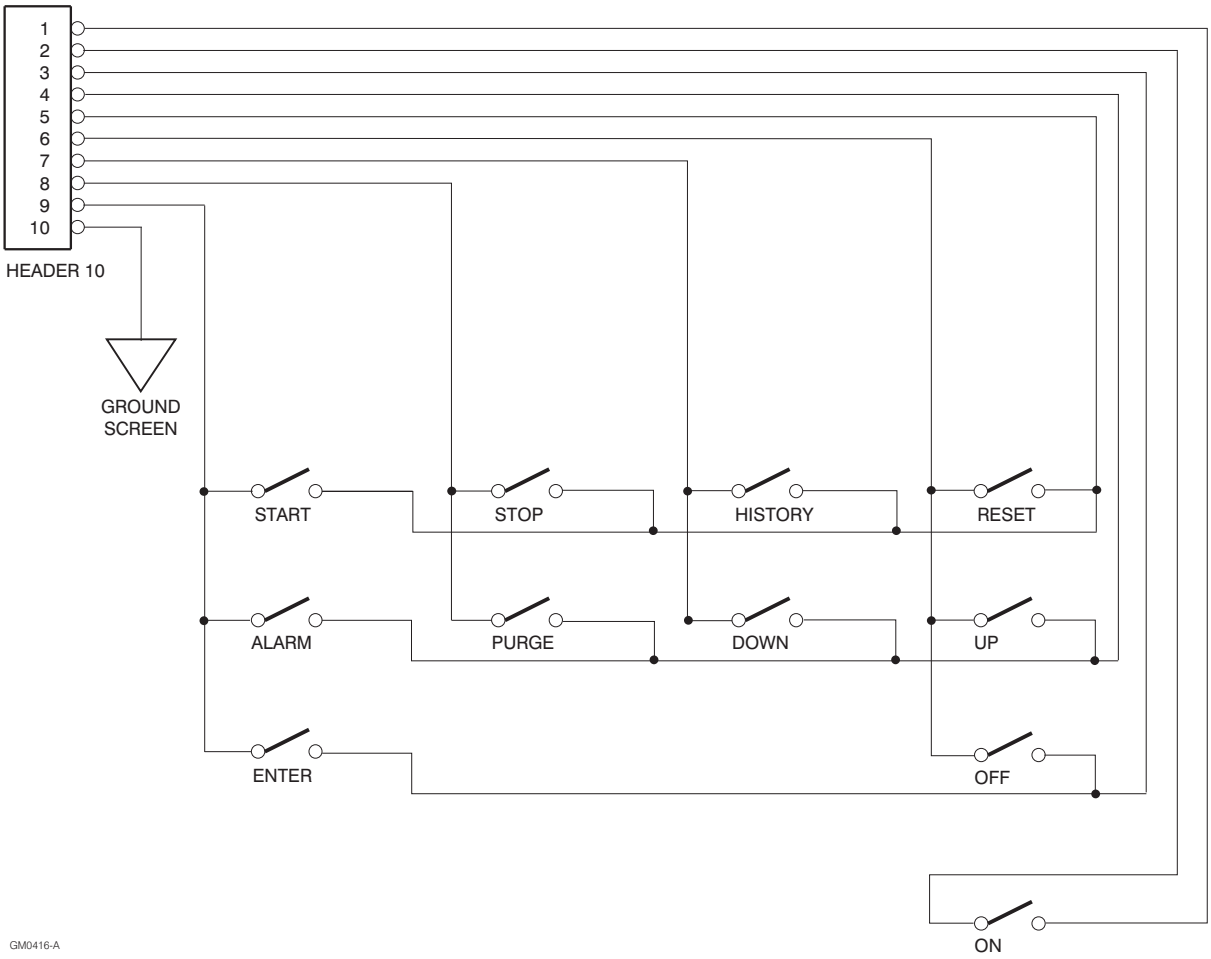
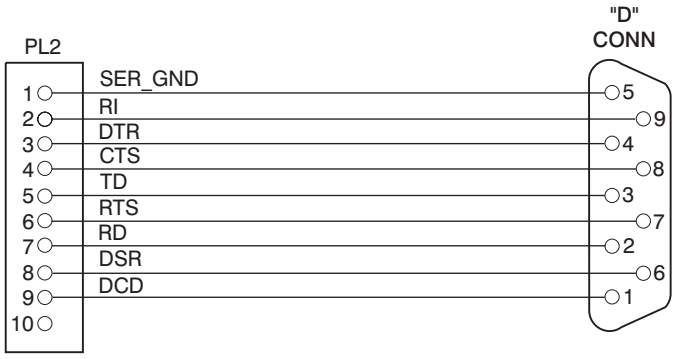


Figure 4.18 Membrane switch panel circuit



NOTE:
The RS232 Serial Interface connections to PL2 are shown on Fig. 4-18

GM0417-A

Figure 4.19 Internal ribbon cable and 'D' connector connections

CHAPTER 5

FAULT CODES, CLEANING, RENEWAL of FUSES and REPAIRS

3200

In-line Pressure Syringe Pump

CHAPTER 5

FAULT CODES, CLEANING, RENEWAL of FUSES and REPAIRS

Fault codes

Comprehensive fault codes have been designed into the software of the 3200, and a fault code number has been allocated to each of the faults that may occur (*Table 5.1*), thus making identification of a particular fault easy to trace and rectify.

The fault codes listed below are for software Version 2.20, and these codes are not expected to change for future software versions.

Table 5.1 Main processor fault codes

Code	Fault	Recommended action
07	Interference or internal circuit	See item 2 on page 5-3
08	Interference or internal circuit	See item 2 on page 5-3
10	Motor or leadscrew	See item 4 on page 5-3
11	Interference or internal circuit	See item 2 on page 5-3
12	Interference or internal circuit	See item 2 on page 5-3
22	Interference or internal circuit	See item 2 on page 5-3
25	Interference or internal circuit	See item 2 on page 5-3
26	Interference or internal circuit	See item 2 on page 5-3
30	Interference or internal circuit	See item 2 on page 5-3
31	Interference or internal circuit	See item 2 on page 5-3
32	Interference or internal circuit	See item 2 on page 5-3
33	Interference or internal circuit	See item 2 on page 5-3
34	Interference or internal circuit	See item 2 on page 5-3
35	Interference or internal circuit	See item 2 on page 5-3
36	Interference or internal circuit	See item 2 on page 5-3
40	Interference or internal circuit	See item 2 on page 5-3

(contd.)

Fault codes
(contd.)

Table 5.1 Main processor fault codes (contd.)

Code	Fault	Recommended action
42	Interference or internal circuit	See item 2, page 5-3
43	Interference or internal circuit	See item 2, page 5-3
45	Interference or internal circuit	See item 2, page 5-3
46	Interference or internal circuit	See item 2, page 5-3
47	Interference or internal circuit	See item 2, page 5-3
51	Interference or internal circuit	See item 2, page 5-3
52	Interference or internal circuit	See item 2, page 5-3
54	Interference or internal circuit	See item 2, page 5-3
55	Interference or internal circuit	See item 2, page 5-3
56	Interference or internal circuit	See item 2, page 5-3
57	Interference or internal circuit	See item 2, page 5-3
58	Interference or internal circuit	See item 2, page 5-3
61	Interference or internal circuit	See item 2, page 5-3
64	Comms. or internal circuit	See item 1, page 5-3
65	Comms. or internal circuit	See item 1, page 5-3
68	Comms. or internal circuit	See item 1, page 5-3
69	Comms. or internal circuit	See item 1, page 5-3
74	Interference or internal circuit	See item 2, page 5-3
75	Interference or internal circuit	See item 2, page 5-3
76	Interference or internal circuit	See item 2, page 5-3
77	Interference or internal circuit	See item 2, page 5-3

(contd.)

Fault codes
(contd.)

Table 5.1 Main processor fault codes (contd.)

Code	Fault	Recommended action
78	Interference or internal circuit	See item 2 below
79	Interference or internal circuit	See item 2 below
80	Interference or internal circuit	See item 2 below
81	Interference or internal circuit	See item 2 below
83	Interference or internal circuit	See item 2 below
85	Power supply fault	See item 5 below
86	Motor fault	See item 4 below
87	Interference or internal circuit	See item 2 below
88	Interference or internal circuit	See item 2 below
90	Interference or internal circuit	See item 2 below
91	Keyboard fault	See item 3 below
92	Interference or internal circuit	See item 2 below

The five items shown in *Table 5.2* (and cross referenced from *Table 5.1*) detail the possible cause of a fault within a pump, and the recommended action to be taken:

Table 5.2 Fault cause and action

Item	Fault	Possible cause	Recommended action
1	Communication (Comms.) fault.	External interference... e.g. static interference or r.f. interference. Circuit fault.	Check communication link and interface cable. Return to Smiths Medical.
2	Internal fault.	External interference... e.g. static interference or r.f. interference. Circuit fault.	Relocate the pump. Return to Smiths Medical.
3	Keyboard fault.	Damaged keyboard.	Replace keyboard.
4	Motor fault.	Faulty motor or leadscrew drive assembly.	Check motor and leadscrew drive assembly.
5	Power supply.	Faulty power supply.	Check the power supply.

Cleaning

WARNING
Do not immerse the pump in any liquids. Immediately wipe off any liquid that may be spilt on the pump.

The outer surfaces of the pump can be cleaned by wiping them over with a damp cloth (soapy if necessary).

Repairs

WARNINGS
The following repairs and procedures must only be carried out by qualified technicians.

Disconnect the pump from the AC supply before opening the casing.

The safety and reliability of the pump may be compromised by the use of parts other than those specified in this Manual.

Renewal of fuses

- FS1 is a fuse located in a DC line and has a 1 amp rating.
- FS2 acts as an AC (time delay) fuse that is rated at 500 mA.
- FS3 is a fuse located in a DC line and has a 2 amp rating.

Access to fuses

1. Disassemble the casing (see page 2-11). This will give access to most of the components on the regulator board.
2. To renew FS2, the protective covering over the faulty fuse must first be prised off. The fuse can be removed and replaced with a fuse of the correct rating and size.
3. Refit the protective covering.
4. To renew a faulty FS1 or FS3 (both are situated on the underside of the board), the three screws that retain the board must be removed.
5. Carefully lift up the board and turn it over to reveal both fuses. Remove the faulty fuse and replace it with a fuse of the correct rating and size.
6. Refit the board and secure with three retaining screws.
7. Reassemble the casing, being careful not to trap any leads.

Main board renewal

The main board is mounted on the front casing. It is held in place by six pozi pan head self-tapping screws.

1. Open the casing (see page 2-11).
2. Disconnect the umbilical connector (PL4) from the main board.
3. Remove and retain the six pan head fixing screws.
4. Displace the main board and then disconnect the membrane switch panel (PL3).
5. Fit a new main board by reversing steps (2) and (3) given above and then close the casing (see page 2-11).
6. Complete tests as specified in Section 6.

Regulator board renewal

The regulator board is mounted on the rear casing. It is held in place by three pan head self-tapping screws.

1. Open the casing (see page 2-11).
2. Remove the two spade connectors and the two ribbon cable connectors from the board.
3. Remove and retain the three screws that hold the board in place.
4. Remove the faulty regulator board.
5. Fit a new regulator board by reversing steps (2) to (3) given above ensuring that the in line AC supply choke that is positioned adjacent to the rear of input connector does not obstruct the positioning of the board.
6. Close the casing (see page 2-11).

Status sensors board renewal

The status sensors board is mounted on the rear case and is held in place by two pan head self tapping screws.

1. Open the casing (see page 2-11).
2. Remove and retain the screw that holds the distribution board tray in place.
3. Remove and retain the screw that holds the plastic cable holder in place.
4. Remove and retain the two screws and washers that hold the status board in place.
5. Ease out the plastic flag from the faulty status board, as the board is lifted away from the pump, being careful not to damage the occlusion disc.
6. Fit a new status board by reversing steps (2) to (5) given above and then close the casing as detailed on page 2-11.
7. Carry out test No. 10 (page 6-3) and the Plunger clamp alarm test (page 6-4).

Plunger clamp and super nut assembly renewal

The plunger clamp and super nut assembly is held in place (in the rear casing) by two guide tubes.

1. Open the casing (see page 2-11).
2. Remove and retain the screw that holds the distribution board tray in place.
3. Remove the narrow spring from the size sensor lever arm.
4. Remove the left and right hand brackets that hold the square lay shaft in place.
5. Displace the square shaft together with the super nut and flag moulding, and remove the entire faulty assembly by lifting the guide tube off its two seatings.
6. Fit the new assembly by reversing steps (2) to (5) given above and then close the casing (see page 2-11).

Pole clamp assembly renewal

1. Remove and retain the two screws that are inserted into the stainless steel bracket on the base of the pump.
2. Remove the faulty pole clamp.
3. Fit the new pole clamp to the pump by placing and tightening the two screws into the bracket.

Leadscrew assembly renewal

The leadscrew assembly is held in the rear casing by two bearing clamp plates. It is also kept under tension by a strong adjustable spring. The keyed coupling bush that screws into the right hand end of the lead screw has a 'left hand' thread[1].

1. Open the casing (see page 2-11).
2. If necessary run the motor on its batteries in order to reveal the small grub screw situated in the occlusion adjusting nut on the right hand side of the leadscrew. Using a 1.5 mm hexagon key loosen the grub screw.
3. Ensuring that the leadscrew does not turn, move the occlusion adjusting nut counter-clockwise (i.e. towards the left) in order to relax the spring tension.
4. Remove and retain the two pan head self tapping screws holding the right hand bearing clamp plate in place; remove and retain the plate.
5. Lift out the leadscrew, together with the motor and gear box. The motor and gear box are coupled at the right hand end of the leadscrew.
6. Uncouple the faulty leadscrew from the motor by pulling it away from the motor shaft.
7. Fit a new leadscrew assembly (see Note below) by reversing steps (2) to (6). Tighten the grubscrew to a torque of 15 ± 2 cNm. Alternatively, renew the motor and gear box assembly as detailed in the following section.

Note:
During the fitting of the new leadscrew the spring assembly may have to be compressed to the left in order to fit it into the appropriate grooves in the rear casing.

8. Ensure that the groove on the syringe size sensor collar (through which the larger telescopic tube slides) fits correctly into the concaved rear casing.
9. Assemble the casing (see page 2-11).
10. Carry out the relevant tests in Section 6, including the occlusion thrust checks (see page 2-13) and also the plunger clamp checks (see page 6-3).

[1] If the l.h. thread coupling bush is removed, the torque required when refitted must not exceed 40 cNm.

Motor and gearbox assembly renewal

There is a plastic coupling between the leadscrew and the gearbox.

1. Open the casing (see page 2-11).
2. Carefully prise open the motor loom retain clip and then disconnect the motor loom connector (PL4) from the distribution board.
3. Remove the leadscrew assembly (see page 5-6). The motor and gearbox assembly is attached to the right hand end of the leadscrew assembly and therefore will be removed with the leadscrew assembly.
4. Detach the faulty motor and gearbox assembly from the leadscrew assembly by pulling the two assemblies apart.
5. Fit the new motor and gearbox assembly by reversing steps (2) to (4) detailed above and then assemble the casing (see page 2-11).
6. Carry out the occlusion thrust checks (see page 2-13) and also the plunger clamp checks (see page 6-3).
7. Complete the relevant tests detailed in Section 6.

Occlusion clutch and disc assembly renewal

The occlusion clutch and disc assembly is situated on the left hand side of leadscrew assembly underneath the status sensor board.

1. Open the casing (see page 2-11).
2. Remove the status sensors board (see page 5-5).
3. Remove the leadscrew assembly (see page 5-6). The motor and gearbox assembly is attached to the right hand end of the leadscrew assembly and will, therefore, be removed with the leadscrew assembly.
4. Remove and retain the two screws and the bracket that holds the clutch and disc assembly in place.
5. Remove the faulty clutch and disc assembly.
6. Fit a new clutch and disc assembly by reversing the steps (2) to (4) detailed above and then assemble the casing (see page 2-11).
7. Carry out the relevant tests in Section 6, including the occlusion thrust checks (see page 2-13) and also the plunger clamp checks (see page 6-3).

Membrane switch panel renewal

The membrane switch panel has an adhesive backing which fixes it to the casing. Take care not to unduly bend the new panel or its flexible cable loom.

1. Open the casing (see page 2-11).
2. Disconnect the panel ribbon cable connector (PL3) from the main board.
3. Starting by lifting a corner, peel the faulty panel away from the case. Remove the panel by pulling the connector out through the slot in the front casing.
4. Remove traces of old adhesive from the front case recess (a cloth lightly dampened with white spirit may be used).
5. From the top of the new panel peel back the paper backing approximately as far as the top of the display window.
6. Push the connector and flexible lead of the new panel through the slot in the case.
7. Align the top edge and sides of the panel with the top and sides of the case recess. Gently rub the top edge of the panel to give light adhesion to the case and then remove the remainder of the protective backing paper.
8. Working from the top downwards and using light pressure lay the panel into the case recess.
9. When the label is positioned correctly into the case recess (i.e. no overhanging edges), use a soft cloth to rub the panel down firmly pushing out any air bubbles at the same time.
10. Connect PL3 to the Main board and assemble the casing (see page 2-11).

Super nut renewal

Early 3200 pumps (pre s/n 56905) were fitted with a half nut. From May 1999, the half nut was replaced with a three-quarter super nut. The following procedures refer to the super nut, which must replace the half nut.

Figure 5.1 Half nut (obsolete)/Super nut

The super nut machined casting (see *Figure 7.2, item 3*) is clamped onto the left hand end of the outer metal tube by an M4 countersunk screw that is tightened into a recess positioned hexagonal nut. It is also attached to the toggle mechanism by a Spirol connecting pin.

1. Open the casing (see page 2-11).
2. Remove the plunger clamp, super nut, toggle and square shaft assembly (see page 5-6).
3. Remove and retain the clamping screw and nut.
4. Lever the two sides of the super nut apart in order to disengage the casting pip from the locating hole in the metal tube.
5. Remove the spirol connecting pin that holds the super nut to the toggle mechanism.
6. Fit a new super nut by reversing steps (2) to (5) detailed above and assemble the casing (see page 2-11).
7. Carry out the relevant tests detailed in Section 6 including the plunger clamp checks.

Syringe size sensors assembly renewal

1. Open the casing (see page 2-11).
2. Disconnect connector PL1 from the syringe size sensors board.
3. Remove and retain the two screws that hold the sensor assembly in place. Remove the faulty assembly.
4. If there is a thin shim attached to the faulty assembly then remove and retain this shim.
5. Fit a new sensors assembly by reversing steps (2) to (4) and close the casing (see page 2-11).
6. Carry out the syringe size sensors test (see Section 6).

If the pump fails to pass the syringe size sensors test it is recommended that the Syringe Size Sensors kit (part number 0137-0025) should be obtained from Smiths Medical and fitted according to the instructions supplied with the kit (also see the Appendix).

Plunger clamp repair

The plunger clamp cover must be removed in order to reach the internally located lock or pin moulding. The casing of the clamp is fixed to the right hand end of the outer tube.

1. Remove and retain the two screws that hold the plunger clamp cover onto the casing and remove the cover.
2. The lock and pin moulding together with the associated spring will now be accessible.
3. As required, fit a new lock and/or pin and assemble the clamp as detailed in paragraph (1) above.

ACAM pressure sensing assembly renewal

The ACAM pressure sensing assembly consists of the pressure board and its moulded housing. Four screws attach the assembly to the metal ACAM sensor plate, and the ACAM sensor assembly is fixed to the side of the pump by an adhesive sealant (Dow Corning 3145).

1. Open the case (see page 2-11).
2. Remove and retain the four short screws that fix the outer moulding in place. Remove the moulding and the inner insulating film.
3. Remove and retain the four inner (longer) sealed screws.
4. Remove and retain the cable clamp screw just below the status sensors board and remove PL5 from the distribution board.
5. Pass the connector through the hole in the case and prise off the sealed ACAM sensing assembly.
6. Remove the faulty pressure sensing assembly from the ACAM sensing assembly.
7. Fit the new assembly by reversing the steps given in (2) to (6). Reassemble the case (see page 2-11).

Batteries. Checks and replacement

WARNING

The internal pump batteries must be disposed of in accordance with the manufacturers instructions. Lead acid batteries must *not* be placed in the normal waste stream.

Smiths Medical recommend that the condition of the three internal batteries is checked at least annually.

The batteries will normally last several years, but if they should fail to charge then all three batteries must be replaced at the same time. The batteries are held in place in the front casing by three-pronged flexible plastic mouldings.

Checks

Switch the pump on and fully charge the batteries for at least 14 hours. Remove the AC power and run the pump at 99.9 ml/hr. If the **LOW BATTERY** alarm appears on the pump's display before 2.5 hours has elapsed then all three batteries should be replaced, as detailed below:

Replacement

1. Open the case (see page 2-11).
2. Noting their orientation, prise out the three faulty batteries. Also noting the connections remove all six spade tags.
3. Reconnect three new fully charged 2 V, 2.5 AH, lead acid, D Cell batteries by reversing the steps detailed in (2) above, ensuring that the two rubber packing spacers that are attached to the pillars are still in place.
4. Close the casing (see page 2-11).

Front and/or rear case repair

In March 1999, a new strengthened and modified front and rear case moulding for the 3000 range of syringe pumps (see *Figure 5.2*) was introduced.

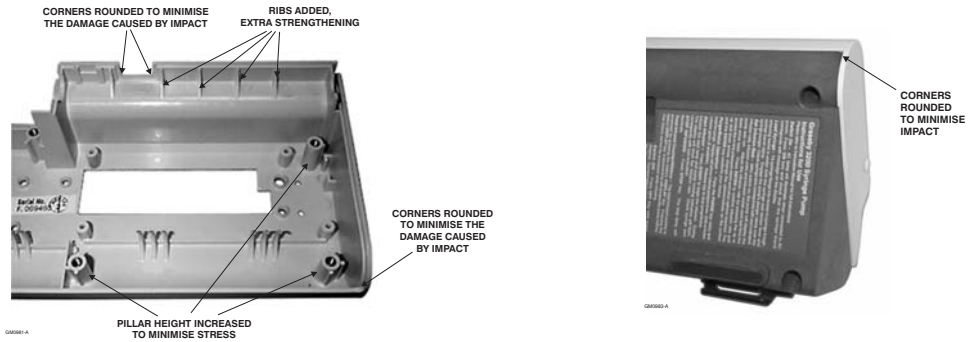

CORNERS ROUNDED TO MINIMISE THE DAMAGE CAUSED BY IMPACT
RIBS ADDED, EXTRA STRENGTHENING
CORNERS ROUNDED TO MINIMISE THE DAMAGE CAUSED BY IMPACT
PILLAR HEIGHT INCREASED TO MINIMISE STRESS
CORNERS ROUNDED TO MINIMISE IMPACT

Figure 5.2 Strengthened front and rear case mouldings

If an old style front or rear case becomes damaged and requires replacing then the appropriate repair kit is available from Smiths Medical. There are two kits (front or rear case) which each contain all the necessary parts to carry out a repair.

The contents of the repair kits are shown in *Tables 5.3, 5.4* and *5.5.*

Table 5.3 Front case spares kit

Description	Part No.	Remarks
Front case spares kit- English	0130-0192	
Front case spares kit- Other	0130-0165	
Case front	0130-0163	
Syringe clamp assembly*	0131-0149	
Button, moulded*	0131-0216	2 off
Instruction leaflet	0131-0156	
Size sensor flag spares kit*	0137-0025	See *Table 5.4*
Foam spacer type 3*	0131-0218	2 off
Case templates*	0131-0235	2 off
Radius gauge*	0131-0234	Stainless steel
Case screws (6 off)	5001-0345	M4x12, pozi pan

***** These items may be obtained individually.

Note:

The Front panel label (membrane) for languages other than English must be ordered separately (see item 3, *Figure 7.1*)

Table 5.4 Size Sensor Flag spares kit

Description	Part No.	Remarks
Size sensor flag spares kit*	0137-0025	
Size sensor flag	0132-0090	
Size sensor shim (0.6 mm thick)*	0130-0107	
Size sensor shim (1.0 mm thick)*	0130-0108	
Size sensor shim (1.2 mm thick)*	0130-0190	
Size sensor shim (1.4 mm thick)*	0130-0185	
Opto moulding	0130-0024	4.65 mm thick
Screws, No. 4 x 5/8 ins. Self tap	5017-3410	2 off
Grub screw, M4 x 6, nylon*	0131-0144	
Tamper proof protective cap*	0131-0136	
Instruction leaflet	0131-0217	

***** These items may be obtained individually.

Table 5.5 Rear case spares kit

Description	Part No.	Remarks
Rear case spares kit*	0130-0171	
Case rear	0130-0188	
Pressure sensing insulat. film	0130-0031	
Foam spacer type 1*	0131-0204	
Foam spacer type 2*	0131-0205	3 off
Foot, rubber*	0126-0028	2 off
Instruction leaflet	0131-0156	
Case screw, M4x12, pozi pan	5001-0345	6 off
Clamp, cable	5366-2820	
Catch, button	0128-0117	
Strip, retaining	0128-0118	
Screw, M3x10 pozi csk	5000-6317	
Screw, M3x6 slot pan		

***** These items may be obtained individually.

Note:
The Case rear label will be Country dependent, and can also be supplied, e.g. 0130-0156, English, 110/240 V

CHAPTER 6

FUNCTIONAL TESTS and MANUFACTURNG SETTINGS

3200

In-line Pressure Syringe Pump

CHAPTER 6

FUNCTIONAL TESTS and MANUFACTURING SETTINGS

Functional tests

The following functional tests have been designed to verify that the 3200 is safe to use. Complete the tests before putting the pump into service for the first time, and then as required.

Table 6.1 Functional tests

Step	Test	Method	Correct result
1	Mechanical inspection.	Before applying power to the unit, check that the case and exposed mechanical parts are free from any damage.	No damage.
2	Electrical safety tests	For routine electrical safety testing, Smiths Medical recommends that units are test tested in accordance with the UK Medicine and Healthcare products Regulatory Authority (MHRA) guideline document MDA DB9801, supplement 1 (December 1999) for Class II, Type CF equipment as a minimum.	
3	Initial power on.	Connect the AC supply. Press **ON**.	The **AC** LED lights. A bleep is heard and all LEDs are briefly illuminated. Following this bleep the syringe type is displayed. The pump then goes into its set-up mode and the **STOP** and **AC** LED's are lit.
4	Syringe sizes.	Perform with plunger clamp 40 mm from RHS and also at extreme LHS. Insert the following rods (in turn) into the syringe trough. 11.2 mm. 12.5 to 15.0 mm. 16.2 to 18.2 mm. 21.0 to 23.0 mm. 23.7 to 26.8 mm. 29.0 to 33.1 mm.	 Invalid syringe condition. **5ml** LED illuminated. **10ml** LED illuminated. **20ml** LED illuminated. **30ml** LED illuminated. **50/60ml** LED illuminated.

Note:

Smiths Medical manufacture a set of 18 Syringe Size Sensor gauges, *part number 0131-0202* (see Appendix, page A-5). The Smiths Medical Customer Care Department is able to take orders for these gauges and will supply the current price. This set of gauges enables test No. 4 to be carried out on all of the Graseby 3000 Series of pumps.

(contd.)

Table 6.1 Functional tests (contd.)

Step	Test	Method	Correct result
5(i)	Keyboard tests. AC connected.	Press **OFF**.	The display is blank but the **AC** LED remains lit.
5(ii)		Press **ON**.	As above (3), Initial power on.
5(iii)		Check that the pump can be programmed by using the ▲ ▼ and **ENTER** keys as described in the Instruction Manual.	Confirm display messages shown in the Instruction Manual, and also confirm that the keys change the settings as required.
5(iv)		Check that the *History*-**display/reset** keys operate correctly as described in the Instruction manual.	Display shows volume infused since last reset, then resets to zero when the **reset** key is pressed.
5(v)		Fit a syringe and move the plunger clamp to the closed position. Programme the pump, then press **START**.	The syringe type and size is displayed. The **START** LED flashes and the display running indicator arrows flash.
5(vi)		Check that the bolus facility functions as described in the Instruction Manual.	**ALARM** and **START** LEDs flash and the bolus delivered is displayed.
5(vii)		Check that the change rate facility functions as described in the Instruction Manual.	The rate of infusion changes.
5(viii)		Whilst infusing, press **STOP**.	The pump will enter its set-up mode.
5(ix)		Press **START** to commence the infusion and then move the plunger clamp to its open position.	The alarm sounds intermittently, the **ALARM** LED flashes and... **PLUNGER CLAMP OPEN** is displayed.
5(x)		In the above alarm state [5 (ix] press the **ALARM** key.	The alarm is silenced and the pump goes into its set-up mode.
6(i)	AC failure.	Press **START** to start the infusion and then switch off or remove the AC supply externally.	The alarm will sound intermittently and ... **AC POWER REMOVED** will be displayed, but the pump will continue running under battery power.
6(ii)		Reconnect the AC supply.	The **AC** LED lights.

(contd.)

Table 6.1 Functional tests (contd.)

Step	Test	Method	Correct result
7	Linear accuracy. Use the linear accuracy gauge (see page 6-5).	Set the following: • syringe type to 60 ml BD • the rate to 99.9 ml. • plunger clamp to 60 ml. Purge the system to remove any backlash then run the pump for exactly 6 minutes.	Check that the plunger clamp moves a distance of 18 ±0.3 mm. See also page 6-5.
8	Occlusion.	The occlusion thrust is factory set by applying an opposing force to the syringe plunger clamp. This is achieved by using weights.	Refer to page 2-13.
9	Plunger clamp alignment.	Close the clamp at mid-position. Run an infusion of at least 99.9 ml/h. After 5 seconds check clamp position.	Front edge of clamp must be between 8 and 10 mm above surface of top cover. See page 6-5, *Fig. 6.4 Taper Gauge*.
	Note: If this test fails then the super nut will have to be loosened, this will allow the plunger clamp to be manipulated up or down a small distance, thus enabling the required 8.0 to 10 mm gap to be achieved.		
10	Plunger clamp open, leadscrew disengaged.	Load syringe and set an infusion rate. Open the plunger clamp. Press **START**.	The alarm ... **PLUNGER CLAMP OPEN** must be activated.
11(i)	Syringe warning, LESS THAN 3 MINUTES TO KVO and, KVO 0.5 ml/h.	Using a BD 60 ml syringe set the plunger clamp to 15 ml before the end of travel. Set KVO rate to 0.5 ml/h in Configuration mode. Run an infusion at 200 ml/h.	The following display will appear ... **LESS THAN 3 MINUTES TO KVO** accompanied by a quiet chirping alarm, followed after three minutes by ... **KVO 0.5 ml/h** accompanied by a loud pulsing alarm.
11(ii)	Syringe warnings, PUMP STOPPED, PUMP NOT RUNNING.	Set and run the pump as in 11 (i) except that the plunger clamp is set to 3 ml before the end of travel.	At the end of travel ... **PUMP STOPPED: EMPTY/OCCLUSION** appears accompanied by a loud pulsing alarm, and after a delay ... **PUMP NOT RUNNING** will appear.
	Note: When carrying out test No. 11(i) on a Perfusor pump ensure that the syringe is set to a minimum of 18 ml.		
12	Transducer Test 3200	Insert Pressure Sensing Disc into sensor housing. Apply pressure of :- 300 mmHg 200 mmHg 100 mmHg 0 mmHg	Observe display. Reading should be:- 295 - 305 mmHg 188 - 212 mmHg 88 - 112 mmHg -8 - +8 mmHg
13	Plunger clamp	If the pump is fitted with the older style half nut (see page 5-8), the Plunger clamp alarm tests alarm tests should be performed (see page 6-4).	

Plunger clamp alarm checks

The following plunger clamp alarm checks are only required on pumps fitted with the old style half nut, and not the more recent super nut (see page 5-8).
The dual ramp gauge (*part number 0131-0084*) is used to check that the ....

PLUNGER CLAMP OPEN

alarm is operating correctly when the plunger clamp is set to two alternative infusing positions, as shown below:

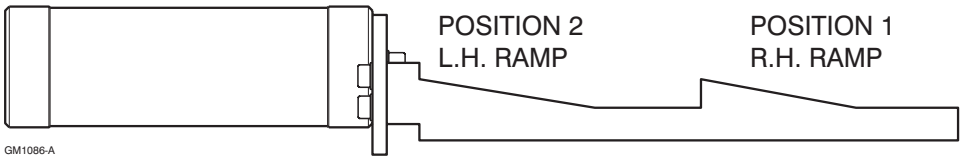


Figure 6.1 Outline of dual ramp gauge

Ramp check procedures

1. Fit the dual ramp gauge onto the pump.
2. Close the plunger clamp at a position that is just clear of the bottom end of the right hand ramp.
3. Set the pump to infuse at a rate of 200 ml/h and press the **START** button.
4. Check that during the first 30 seconds of travel (as the leadscrew is fully engaged), that the plunger clamp remains clear of the ramp.
5. Check that as the plunger clamp runs up the right hand ramp a ...

   PLUNGER CLAMP OPEN

   alarm occurs within 10 minutes of pressing the **START** button.
6. Repeat the above check with the plunger clamp placed just clear of the left hand ramp.

If the pump fails the ramp gauge checks (on the earlier manufactured pumps) it is recommended that the half nut is changed for a super nut (see page 5-8). Also ensure that the three following modified items have been fitted:

1. A new style square shaped flag (*part number 0127-0019*, as shown below) in place of the old style flag.
2. A new style shaft bracket (*part number 0127-0052*, as shown below). This bracket is identified by a 'V' notch that appears on one of the prongs.
3. Two new thicker washers (*part number 5014-3020*) in place of the previously fitted thinner washers that are used for fixing the opto sensors board.

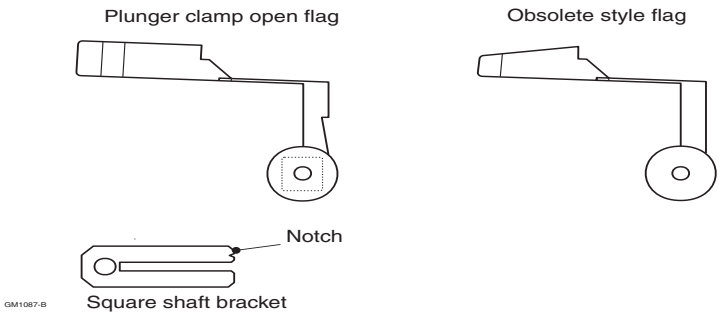


Figure 6.2 Ramp check - Square/Ramp style flags

Linear accuracy

The linear accuracy gauge (*Figure 6.3, part number 0131-0230*) when placed on the pump, is able to check that the pump's plunger clamp moves a given distance in a specified time. Initially, the pump will have been preset to given parameters, then set to run for a specified time and the distance that the plunger moves being observed on the measurement dial of the gauge.

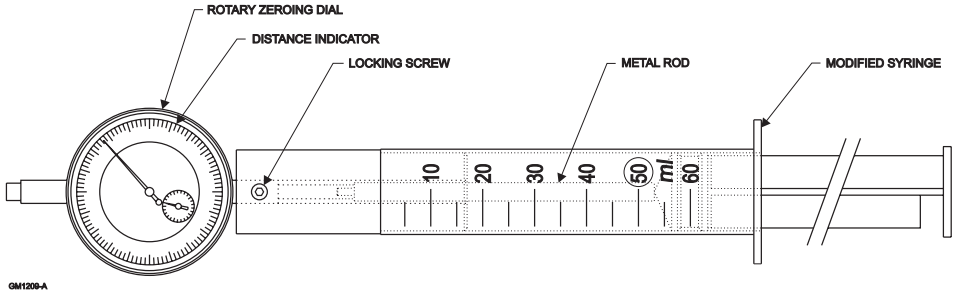


Figure 6.3 Linear accuracy gauge

Test procedures

Test No. 7, see page 6-3

1. Place the gauge onto the pump with the syringe plunger almost fully extended.
2. Move the pump's plunger clamp to the left until the gauge plunger is a short distance away from the metal rod that activates the dial indicator.
3. Turn the pump on and check that the pump shows that the syringe brand and size is BD 60 ml.
4. Press the **PURGE** button until the syringe plunger just activates the gauge indicator. This action ensures that any pump backlash is removed.
5. Rotate the outer rim of the gauge to set both dial indicators to zero.
6. Set the pump to deliver an infusion at 99.9 ml/hour.
7. Run the pump for exactly 6 minutes and check that the gauge dial records that the plunger has moved between 17.7 and 18.3 mm.

Plunger clamp alignment

The taper gauge (*Figure 6.4*, *part number 0131-0227*) enables the gap between the pump's plunger clamp and the case to be measured accurately. This measurement is important as it ensures that the plunger clamp will engage onto the flanges of the smaller sized syringes correctly.

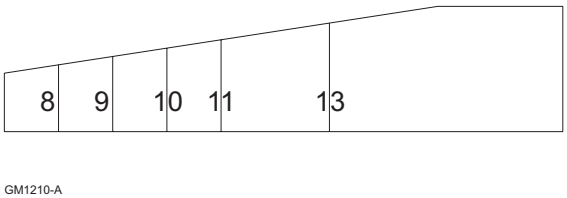


Figure 6.4 Taper gauge

Test procedures

Test No. 9, see page 6-3

1. Switch the pump on and set the rate to at least 99.9 ml/hour.
2. Close the plunger clamp at approximately its mid-position.
3. Run the pump for 5 seconds.
4. Using the taper gauge, check that the front edge of the plunger clamp is between 8.0 mm and 10.0 mm above the surface of the case.

Manufacturing settings

When the tests of *Table 6.1* have been completed, the pump can be returned to the manufacturing settings (if required) as shown in sequence in *Table 6.2.*

The settings marked with an asterisk (*****) in *Table 6.2* are intermediate settings that are initially selected in order to allow several other associated settings to appear in the Configuration mode. Ultimately, the final sequence of Manufacturing settings are selected as shown in the latter part of *Table 6.2.*

Table 6.2 Manufacturing settings

	Option	Setting
	Configuration mode:	
1	Syringe type	BD PLASTIPAK
2	Syringe size	NOT LOCKED
3	Lock program values	NO
4	Max infusion rate	200 ml/h
5	Select pump modes	ALL MODES AVAILABLE *
6	Preset volume mode with time	YES
7	KVO Rate	0.5 ml/h
8	Allow mass units option	YES *
9	Infusion units mg/kg/h	YES
10	Infusion units mg/kg/min	YES
11	Infusion units µg/kg/h	YES
12	Infusion units µg/kg/min	YES
13	Infusion units mg/h	YES
14	Infusion units µg/h	YES
15	Show rate in ml/h while infusing	YES
16	Use pressure transducer	YES
17	Display pressure bargraph	YES
18	Allow bolus while running	NO
19	Allow rate change while running	NO
20	Intermittent mode start delay	YES
21	RS232 baud rate	9600
22	Communication mode	NONE
23	Pump ID	GRASEBY_3200 (see Note over page)
24	Set key beep volume	5
25	Pressure units	mmHg
	Setup mode:	
1	Infusion mode	INTERMITTENT *
2	Dose volume	0.2 ml
3	Dose duration	STAT
4	Dose cycle time	4 hours 0 minutes
5	Background rate	0.00 ml/h
6	Start delay	0 hours 0 minutes
7	Pressure limit	75 mmHg
8	Infusion mode	PRESET VOLUME *
9	Infusion rate	1.0 ml/h
10	Preset volume	0.2 ml/h
11	Infusion mode	CONTINUOUS
12	Infusion units	mg/kg/h *
13	Patient body weight	0.40 kg
14	Drug mass	1.0 mg
15	Drug volume	60 ml
16	Infusion rate	0.01 mg/kg/h
17	Infusion units	ml/h

(contd.)

Table 6.2 Manufacturing settings (contd.)

	Option	Setting
	Configuration mode:	
5	Select pump modes	CONTINUOUS & PRESET
6	Preset volume mode with time	NO
8	Allow mass units	NO
	Set-up mode:	
1	Infusion mode	PRESET VOLUME
9	Infusion rate	1.0 ml/h
10	Preset Volume	0.2 ml

Note:
The pump ID (item 23) accepts 12 characters exactly. A blank space is not provided.

CHAPTER 7

ILLUSTRATED PARTS LIST

3200

In-line Pressure Syringe Pump

CHAPTER 7

ILLUSTRATED PARTS LISTS

Figure 7.1 General assembly

Item	Description	Part number	Remarks
	Model 3200		
	- English	0130-0001	
	- 110 V model	0130-0701	
	- Italian	0130-0704	
	- Spanish	0130-0705	
	- German	0130-0707	
	- Dutch	0130-0709	
	- German Perfusor	0130-0714	
	- English without plug	0131-0721	
	- English with Euro mains plug	0130-0728	
	- Australian	0130-0740	
	- English 12 V DC	0130-0730	
	- Norwegian 12 V DC	0130-0735	
1	Front case spares kit, (NOT English),	0130-0165	See page 5-11
	Kit contains: Front case, Syringe barrel clamp assy, Radius Gauge, Case Templates, Moulded button (x2), Foam spacer (x2), Size sensor flag kit, Screws M4x12 (x6) and Instruction leaflet		
	Front case spares kit (English ONLY),	0130-0192	*see page 5-11*
	Kit contains: Front case, Syringe clamp assembly, Button moulded (x2), Size sensor flag spares kit, Foam spacer type 3 (x2), Front panel label 3200 (English), Radius gauge, Case templates, Screws M4x12 (x6) and Instruction leaflet,		
2	Rear case spares kit	0130-0171	*see page 5-11*
	Kit contains: Rear case, 4 Foam spacers, Foot, rubber (x2), Pressure sensing insulating film, Screws M4x12 (x6), Clamp, cable, Button catch, Retaining strip, Screw M3x10, Screw M3x6 and Instruction leaflet.		
3	Membrane front panel label		
	- English	0130-0007	
	- Dutch (same as English)	0130-0007	
	- German	0130-0064	
	- Italian	0130-0060	
	- Spanish	0130-0134	

Figure 7.1 General assembly (contd)

Item	Description	Part number	Remarks
4	Rear panel instruction label - see table below **IMPORTANT: When ordering a CE marked rear label, please supply the serial number details of the Syringe Pump, if this information is not supplied then a Non-CE marked label will be issued. It is the responsibility of the owner to ensure that the correct labels are replaced on the pump.**		

3200 pump model numbers	Non CE marked serial no's below 46035	CE marked Made in UK serial no's from 46035 to 89999	CE marked Made in Malaysia serial no's from 90000
0131-0001, English 240V 0131-0721, English (without plug) 0131-0728, English (euro plug)	0130-0156	0130-0008	0130-0194
0131-0701, English 110V	0130-0156	0130-0008	not available
0131-0704, Italian	0130-0180	0130-0061	0130-0197
0131-0705, Spanish	0130-0179	0130-0135	0130-0198
0131-0707, German	0130-0178	0130-0082	0130-0196
0131-0709, Dutch	0130-0182	0130-0069	0130-0199
0131-0714, German (Perfusor)	0130-0178	0130-0082	0130-0196
0131-0730, English DC	0130-0111	0130-0191	0130-0195
0131-0735, Norwegian DC	not available	0130-0118	0130-0200
0131-0740, Australian	0130-0156	0130-0008	0130-0194

5	Case screws	5001-0345	6 required
6	Motor and gearbox assembly	0131-0015	
7	Leadscrew assembly		see *Figure 7.4*
8	Occlusion sensing assembly	0131-0067	
9	Support tube	0127-0047	
10	Plunger clamp assembly		see *Figure 7.2*
11	Nearly empty flag kit	0131-0122	2 types of flag supplied
12	Syringe barrel clamp assembly	0131-0149	
13	Size sensor flag retainer kit,	0131-0238	
	Kit contains: Size sensor flag, anchor plate assembly, Size sensor spring		
14	Bearing clamp bracket	0127-0053	
15	Leadscrew bearing bracket	0127-0051	
16	Square shaft bracket	0127-0052	
17	Main PCB assembly	0130-0009	see *Figure 7.5*
18	Regulator PCB assembly		
	- Regulator PCB assembly - AC Power	0130-0013	see *Figure 7.6*
	- Regulator PCB assembly - DC Power	0130-0101	
19	Transformer	0130-0021	AC Power only
20	Opto sensors board	0128-0090	
21	Opto sensors cable	0053-0670	

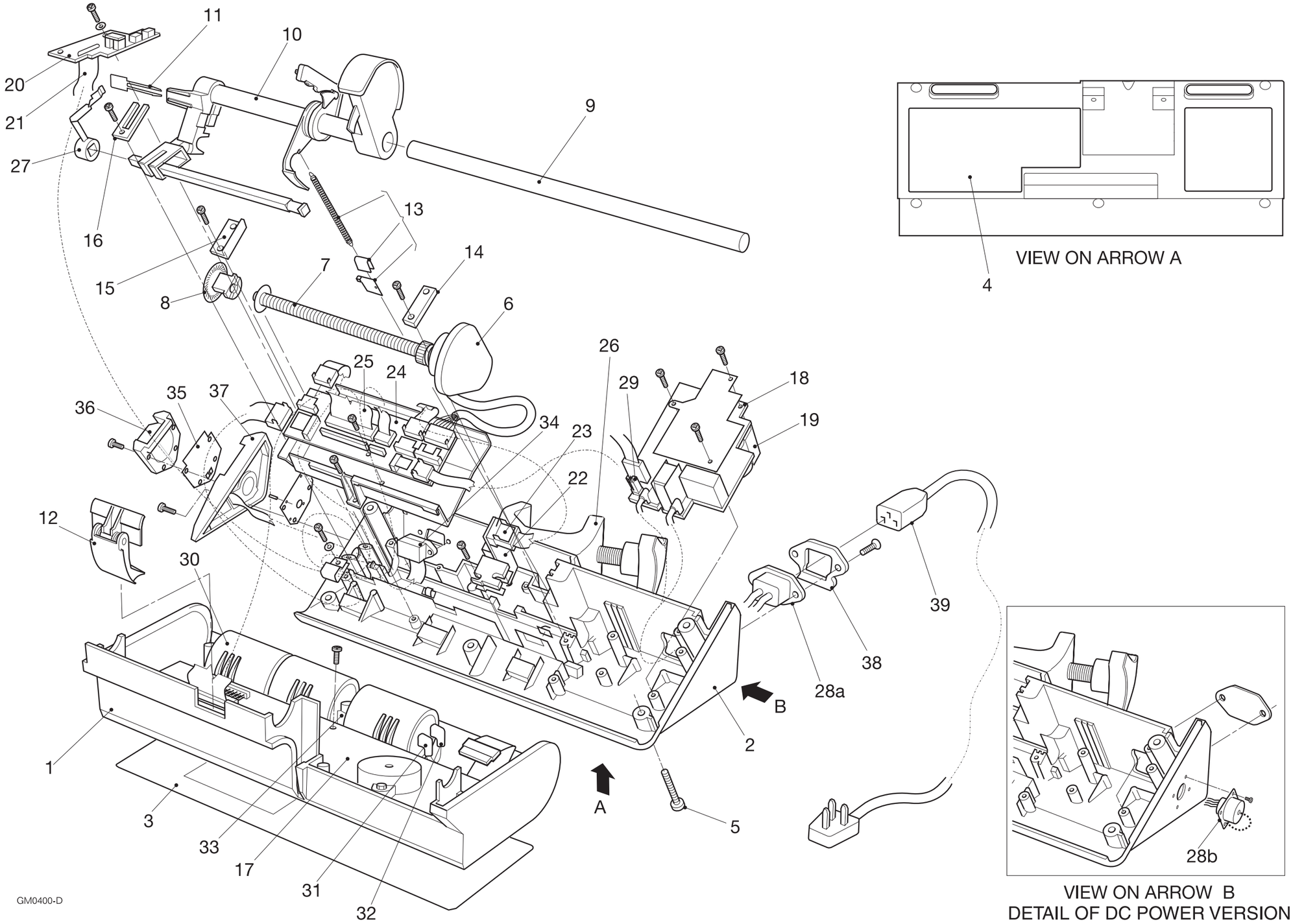


Figure 7.1 General assembly

Figure 7.1 General assembly (contd)

Item	Description	Part number	Remarks
22	Size sensors PCB assembly	0130-0017	
23	Cable assembly size sensor	0053-0678	
24	Distribution board assembly	0130-0027	
25	Cable assembly - Distribution to Main board	0053-0687	
26	Pole clamp assembly		
	- Non-rotating pole clamp	0131-0129	*see Figure 7.3a*
	- Rotating pole clamp	0131-0083	*see Figure 7.3b*
27	Plunger clamp open flag	0127-0019	
28	Mains cable assembly		
	- AC Power	0053-0646	Internal; two wire
	- DC Power	0053-0702	Internal; two wire
29	Power cable assembly	0053-0680	
	PL11 (Regulator board) to PL6 (Distribution board)		
30	Battery - Cyclon *(was P/N 3420-2120)*	0151-0649	3 required
31	Cable assembly battery A	0053-0647	
32	Cable assembly battery B	0053-0648	
33	Cable assembly battery C	0053-0649	
34	Cable assembly D connector	0053-0657	
35	ACAM sensor insulating film	0130-0031	
36	ACAM sensor top moulding	0130-0043	
37	ACAM pressure sensor assembly	0130-0033	
38	Cable clamp	0127-0043	
39	Cord set		
	- UK	3700-0046	
	- AC power, 110 V	3700-0230	
	- Spanish, French, German	3700-0035	
	- Italian, without plug	3700-0025	
	- Dutch	3700-0044	
	- Australian	3700-0056	
40	Instruction Manual		Not illustrated
	- English	0130-0044	
	- Dutch	0130-0099	
	- German	0130-0084	
	- Italian	0130-0152	
	- Norwegian	0130-0095	
	- Spanish	0130-0137	
41	Technical Service manual	00SM-0130	Not illustrated
42	Size sensor gauge set/kit	0131-0202	Not illustrated
	Kit contains: 18 size sensor gauges, Instruction leaflet for calibration		
43	PC interface cable assembly	0053-0704	Not illustrated

Figure 7.1 General assembly (contd)

Item	Description	Part number	Remarks
44	5/10 ml adaptor plate	0132-0076	Germany only
45	Perfusor conversion kit	0131-0048	Not illustrated.
	Kit contains the following items: Perfusor spacer tube, nearly empty flag for Perfusor, Plunger clamp plate, 'P' label.		*see Chap. 8 for conversion procedure.*
46	Linear accuracy gauge	0131-0230	*see page 6-4*
47	Taper gauge	0131-0227	*see page 6-4*
48	Dual ramp gauge	0131-0084	
49	Security cover spares kit,	0131-0151	Not illustrated
	Kit contains: Pole clamp assembly, Syringe cover, Cover pin bearing (x2), Cover pin (x2), Compression ring (x2), Circlip (x2), Torx screw (x2), Retaining strip, Button catch, Drilling template, Loctite 638, Screw M3x6 slotted pan, Screw M3x10 csk pozi and Instruction leaflet		

Figure 7.2 Plunger clamp and half nut assembly

Item	Description	Part number	Remarks
1	Plunger clamp and tube	0127-0044	
2	Plunger clamp cover and internal kit	0131-0239	
	Kit contains: Plunger clamp cover, Plunger clamp lock, Plunger clamp pin, Plunger clamp conical spring, Plunger clamp finger spring		
3	Half nut casting	0131-0042	See *Figure 7.4*
4	Toggle moulding	0127-0026	
5	Toggle glide moulding	0127-0027	
6	Toggle spring	5752-0010	
7	Size sensor flag spares	0137-0025	
	Kit contains: Size sensor flag moulding, Protective cap, Grub screw M4 x 6, Size sensor shim (x4), Size sensor moulding, Instruction leaflet, screw s/tap (x20		
8	Square shaft	0127-0048	

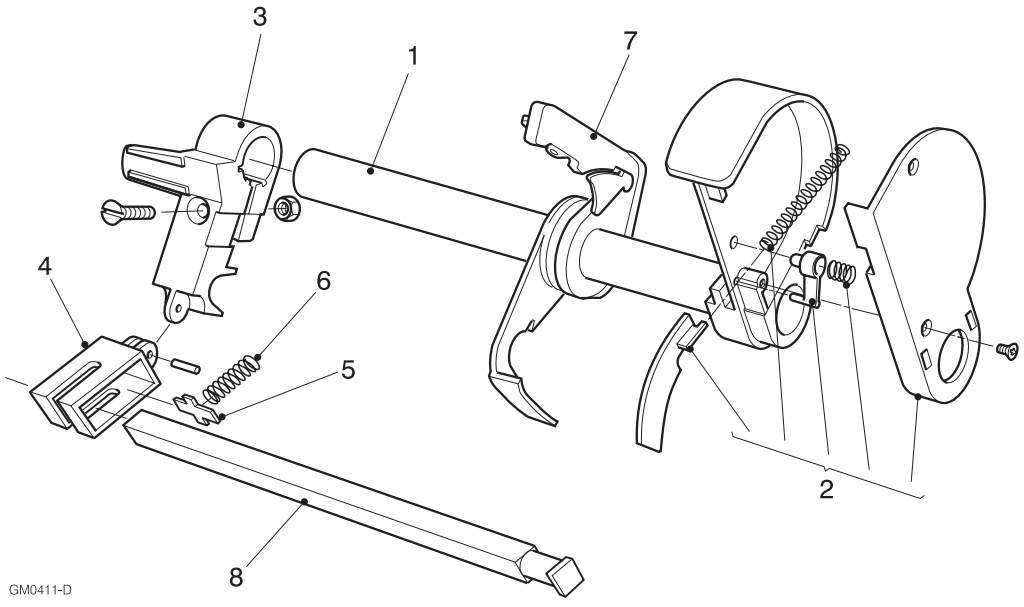


Figure 7.2 Plunger clamp and half nut assembly

Fig. 7.3a Pole clamp assembly: non-rotating

Item	Description	Part number	Remarks
	Pole clamp assembly (new version)	0131-0129	
1	Pole clamp cap-knob	788098-2890-4	

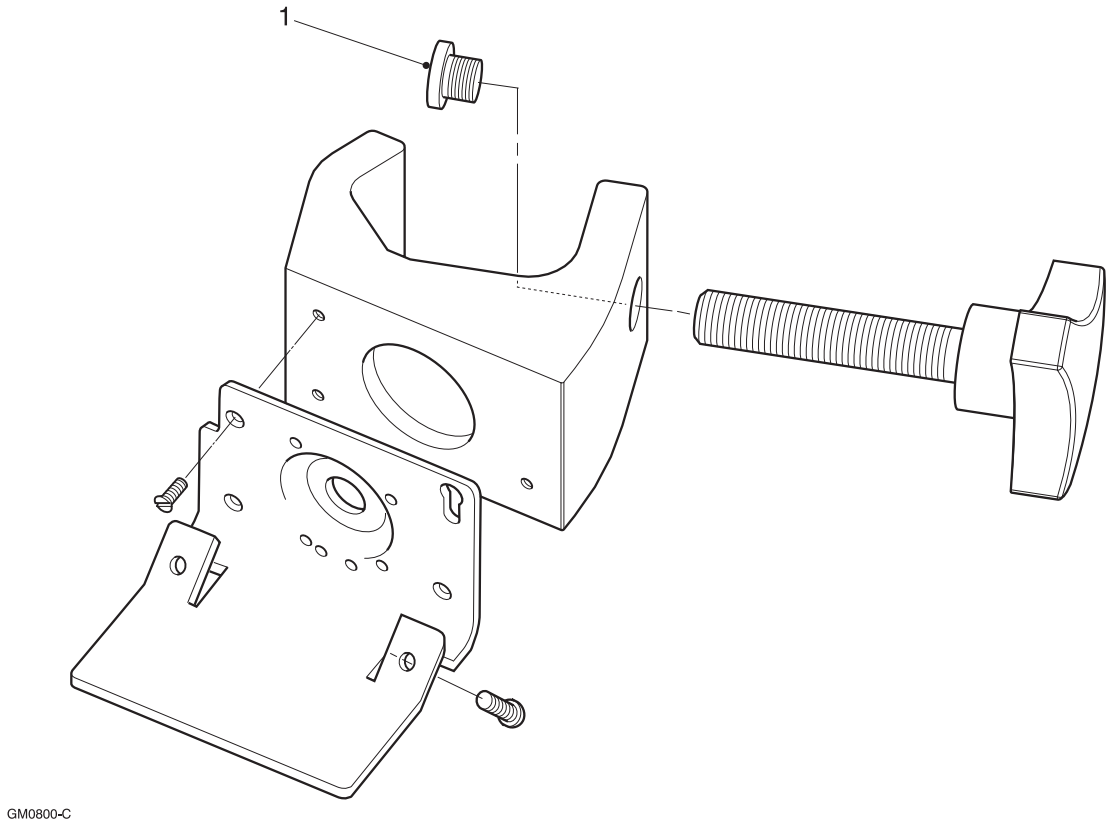


Figure 7.3a Pole clamp assembly - Non-rotating

Fig. 7.3b Pole clamp assembly: Rotating

Item	Description	Part No.	Remarks
	Rotating pole clamp assembly	0131-0083	
1	Securing plate	0131-0074	
2	Locating ring	0127-0064	
3	Handle	0127-0060	
4	Pole clamp body	0131-0061	
5	Crescent circlip	5030-5710	
6	External circlip type 7100-010	5030-4010	
7	Spirol pin 3 x 26	5028-3408	
8	Clamp pad kit containing:	0131-0052	
	Clamp bolt, Clamp pad, Spacer, End cap, Screw M3 x 12, Instruction sheet.		

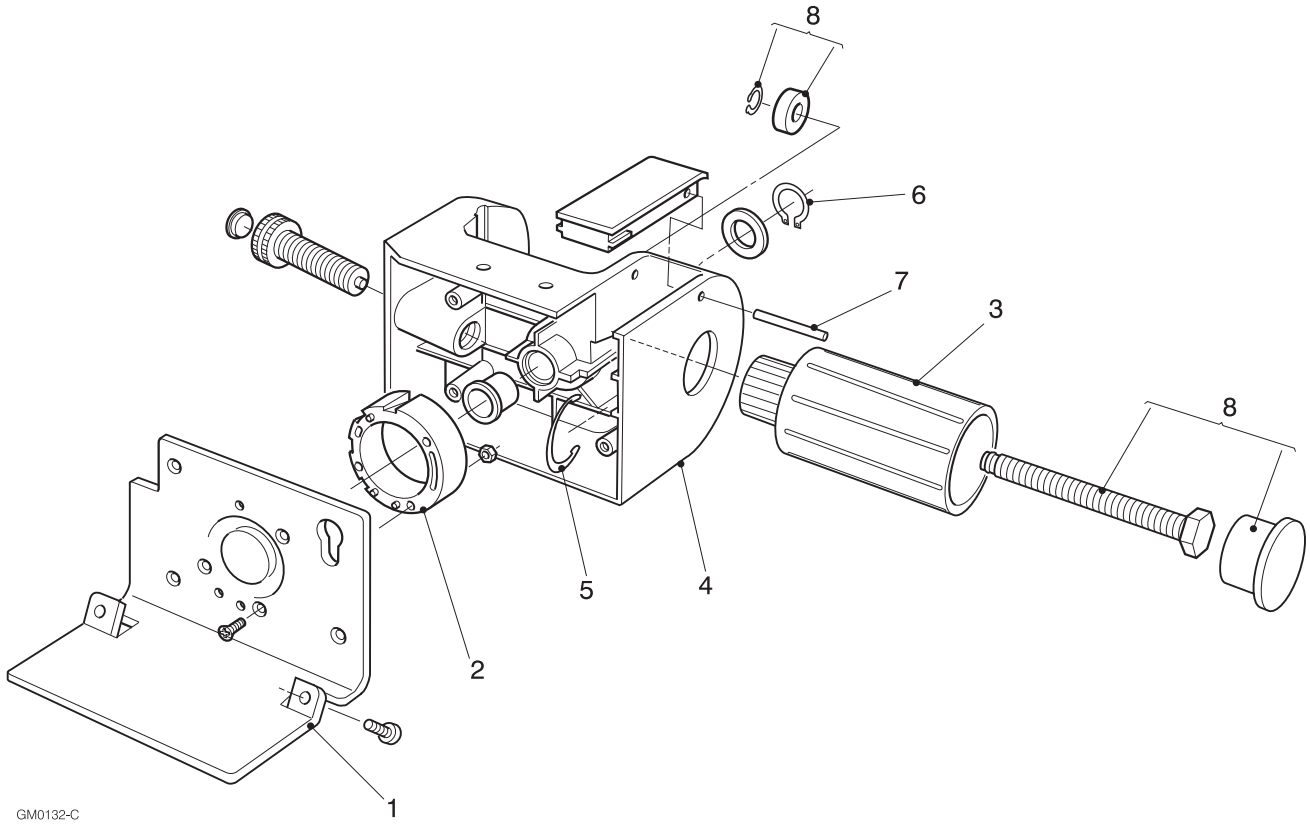


Figure 7.3b Pole clamp assembly - Rotating

Figure 7.4 Leadscrew assembly

Item	Description	Part number	Remarks
	Leadscrew and half nut kit comprising:	0131-0236	
	Leadscrew assembly, Half nut casting, 2 different flags, 1 screw, 1 nut and Instruction sheet		
1	Half nut casting	0131-0042	
2	Leadscrew assembly	0131-0119	
3	Leadscrew coupling	0127-0074	

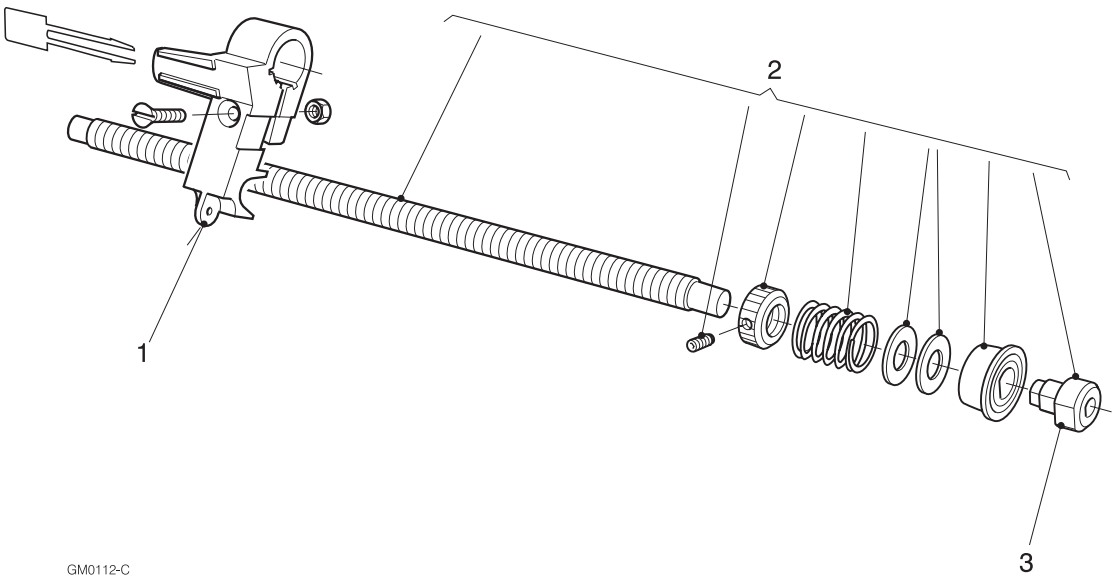


Figure 7.4 Leadscrew assembly

Figure 7.5 Main board assembly

Item	Description	Part number	Remarks
	3200 Main board assembly	0130-0009	
1	Sounder	3430-1205	
2	Sounder restraint kit comprising:	0131-0240	
	Kit contains: Nut M3 - 2 off, Screw M3 x 16 - 2 off, Pillar - 2 off		
3	IC13, Programmed EPROM	0130-0040	
4	Display module (VFD)	0130-0019	
5	IC14, (initialised) 8HC11K1CFN4	0130-0089	

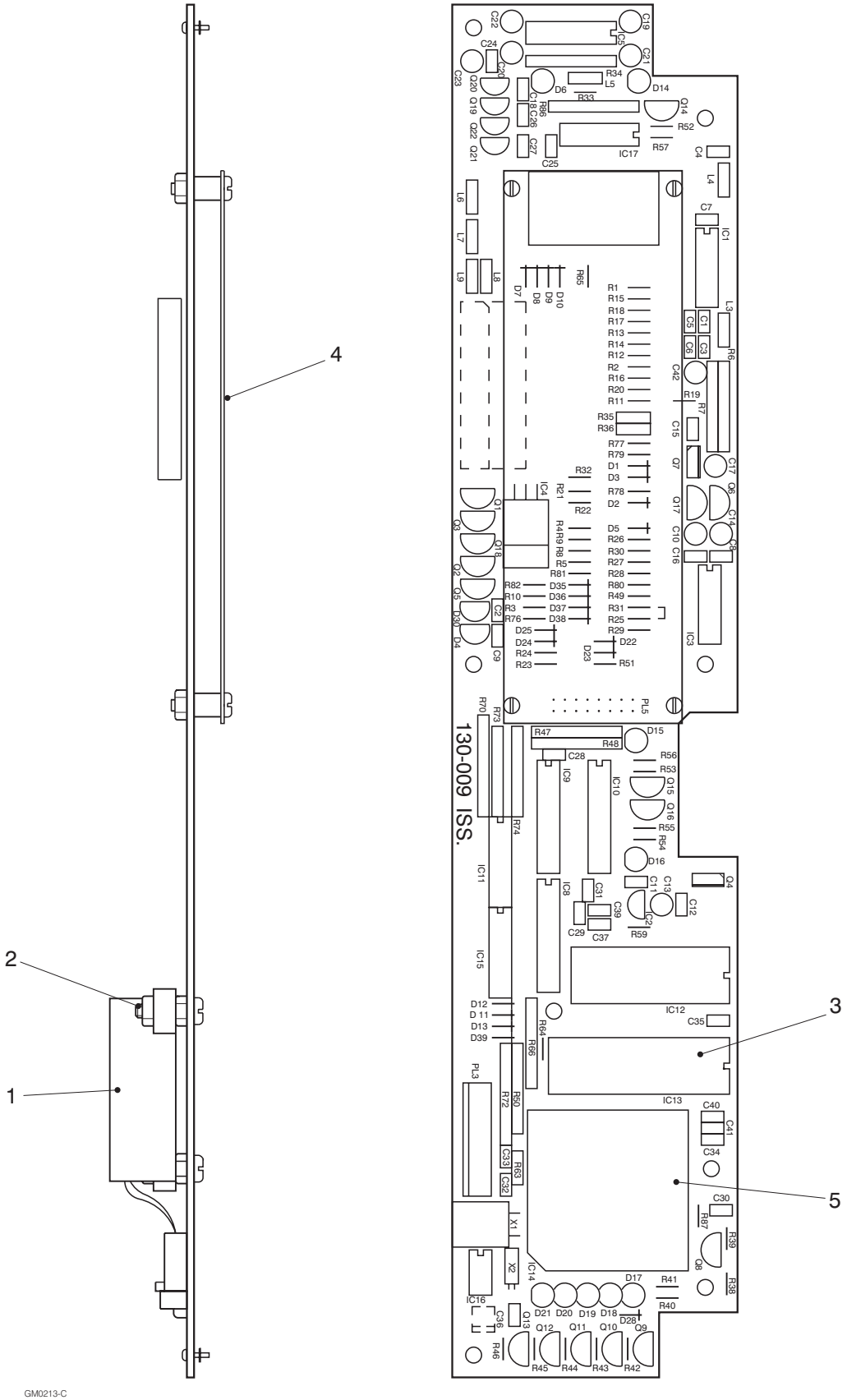


Figure 7.5 Main board assembly

Figure 7.6 Regulator board assembly - AC Power

Item	Description	Part number	Remarks
	Regulator board assembly - AC power	0130-0013	
1	Fuse cover	3412-0228	
2	FS1, Fuse F1A 5 x 20 mm,	3410-3705	BUSSMANN S500
3	FS2, Fuse T500 mA 5 x 20 mm	3410-3003	BUSSMANN GMD
4	FS3, Fuse F2A 5 X 20 mm,	3410-4505	BUSSMANN S500
5	IC voltage regulator	2800-0020	
6	IC voltage regulator	2800-0040	

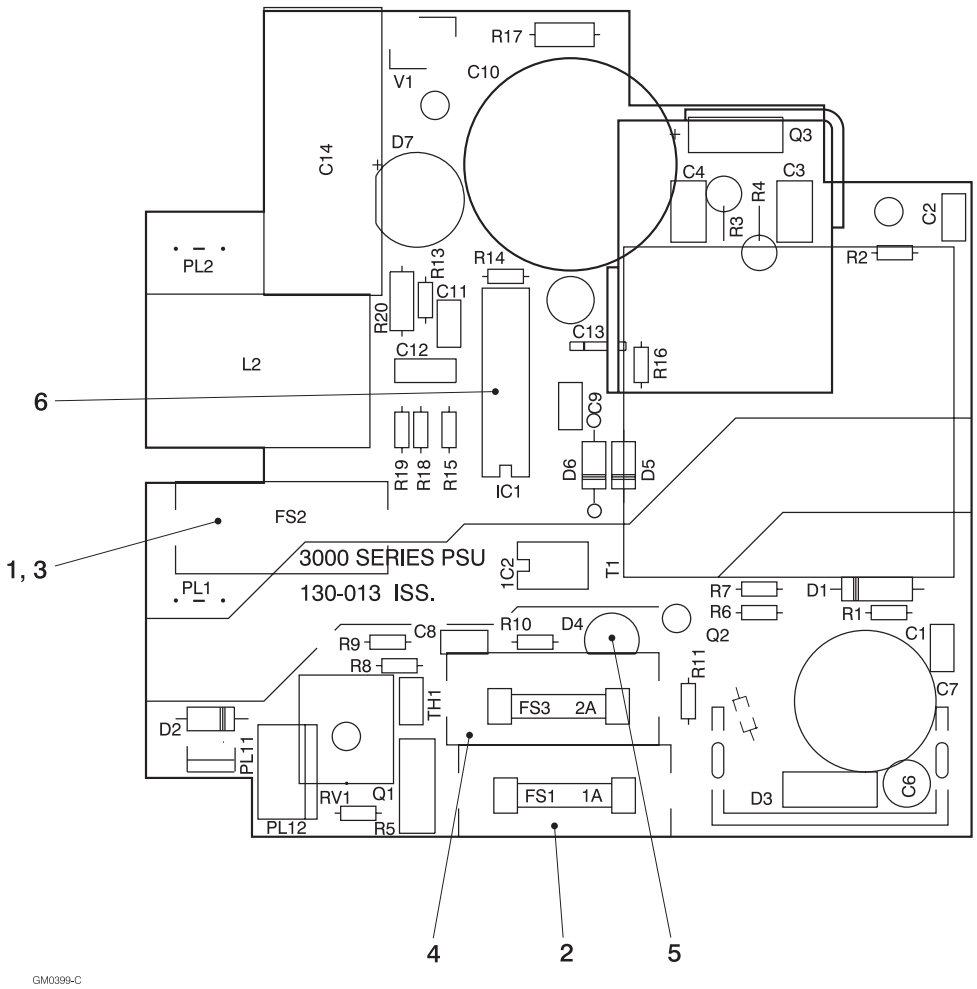


Figure 7.6 Regulator board assembly - AC Power

CHAPTER 8

BRAUN PERFUSOR CONVERSION

3200

In-line Pressure Syringe Pump

CHAPTER 8

BRAUN PERFUSOR CONVERSION

Syringe conversion procedures

Introduction

The 3200 can, if required, easily be converted to use the 'Braun Perfusor 50 ml syringe'. The Perfusor conversion kit part number is 0131-0048.

The conversion procedures are detailed below (see *Figure 8.1)*.

Nearly empty flag conversion

Open the pump case (see page 2-11) and temporarily displace the Distribution board assembly (see *Figure 7.1*) by removing the screw at the bottom of the assembly.

Remove the standard flag from the top of the half nut (retain the standard flag for possible future use). Fit the elongated Perfusor 50 ml nearly empty flag (see page 7-25) by inserting the flag into the grooves on the half nut (see *Figure 8.1*). Ensure that the flag is fitted so that the small amount of flag bias is in the direction of the arrow shown in *Figure 8.1*.

Note:

If not already biassed, bend/bias the end of the flag in the direction of the arrow shown in *Figure 8.1* a distance of approximately 2 mm, this will ensure that the flag (when it moves fully to the left) does not touch the left hand post.

Spacer tube fitment

Carefully lift the left end of the inner metal tube and fit the nylon spacer tube (part number 0131-0051) over the tube. The spacer tube acts as an end of travel stop when the half nut assembly is moved to the left.

Plunger clamp fitment plate

Fit the self adhesive half-round plunger clamp plate (part number 0131-0073) to the left hand side of the plunger clamp. It must be fitted to the vertical face of the plunger clamp so that it covers both quadrant vanes (see *Figure 8.1*).
Reassemble the case (see page 2-11).

Braun Perfusor selection

The Braun Perfusor 50 ml syringe is selected for use (on the pump) by using a special configuration command.

First select the configuration mode (see page 2-1) and then select and display the syringe brand screen.

Simultaneously press the following three buttons:

ALARM, PURGE and **OFF.**

The pump will then switch to the Braun Perfusor syringe mode and other syringe brands will automatically be disabled. The pump syringe display will show:

BRAUN PERFUSOR 50 ml

and the **CHANGE** button, whilst in this mode is ineffective.

'P' label fitment

Fit the self adhesive 'P' label (part number 0131-0065) to the front of the pump in the area just above and to the right of the product name (see *Figure 8.1*). This label acts as a visual reminder that the pump must only be used with the Braun Perfusor syringe.

Reselecting 'various' syringe brands

Mechanical procedures

To reselect the various syringe brands carry out the following mechanical and programming procedures:

1. Take the case apart (see page 2-5).
2. Replace the original standard nearly empty flag.
3. Remove the nylon spacer from the left hand side of the inner metal tube.
4. Remove the adhesive plunger clamp plate.
5. Reassemble the case.
6. Remove the adhesive 'P' label from the front of the pump.

Programming procedures

1. With the pump switched **ON** and

   BRAUN PERFUSOR 50 ml

   displayed within the configuration mode (see page 2-1), simultaneously press the following three buttons:

   ALARM, PURGE and OFF

   in order to set the configuration mode so that the various brands of syringe may be selected.

2. Set the pump to the brand of syringe that is going to be used and then press the **STOP** button in preparation for the next infusion.

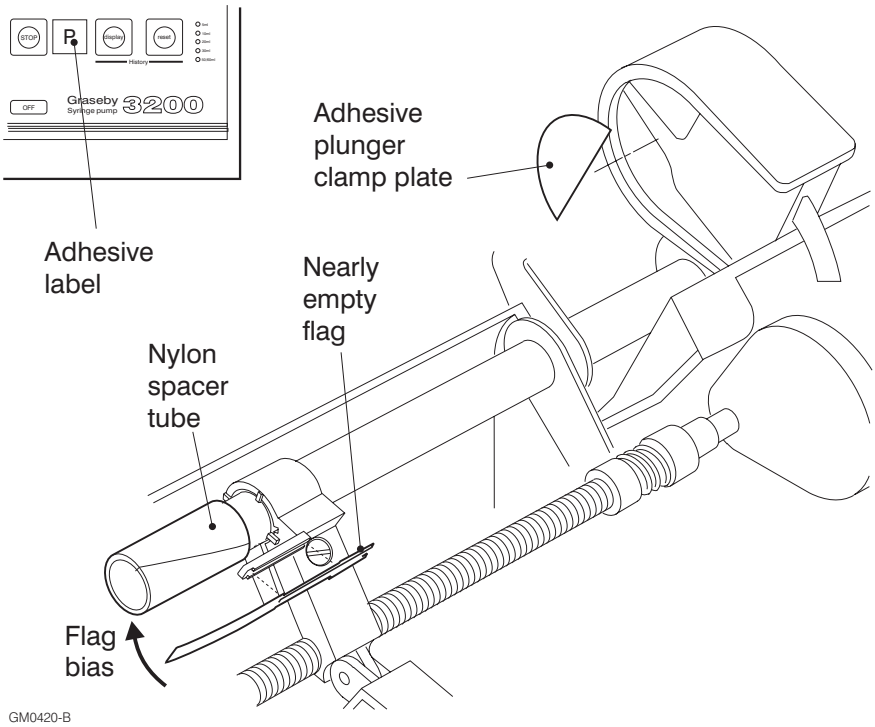


Figure 8.1 Braun Perfusor conversion: parts required

CHAPTER 9

DC INPUT VERSION of 3200

3200

In-line Pressure Syringe Pump

CHAPTER 9

DC input version of 3200

Introduction

The following information is intended for users of the DC version of the 3200. The DC pump is primarily intended for use in an aviation environment, but may also be used in other environments such as ambulances.

The information contained in this Service Manual will still apply and be valid to the operation of the pump, the exception is that for AC supply read DC supply.

DC external input supply

DC supply: 10 V to 28 V DC, at a maximum consumption of 4 amps.

Mating connector: Amphenol 62GB16F82S or direct equivalent.

Pin connections: Pin A is positive.
Pin B is negative.

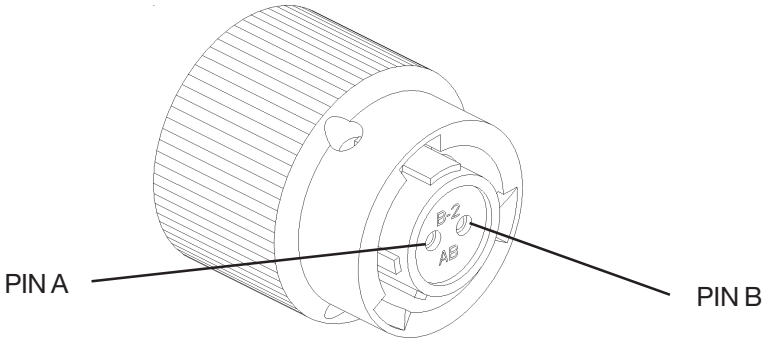


Figure 9.1 Diagram of pump chassis connector

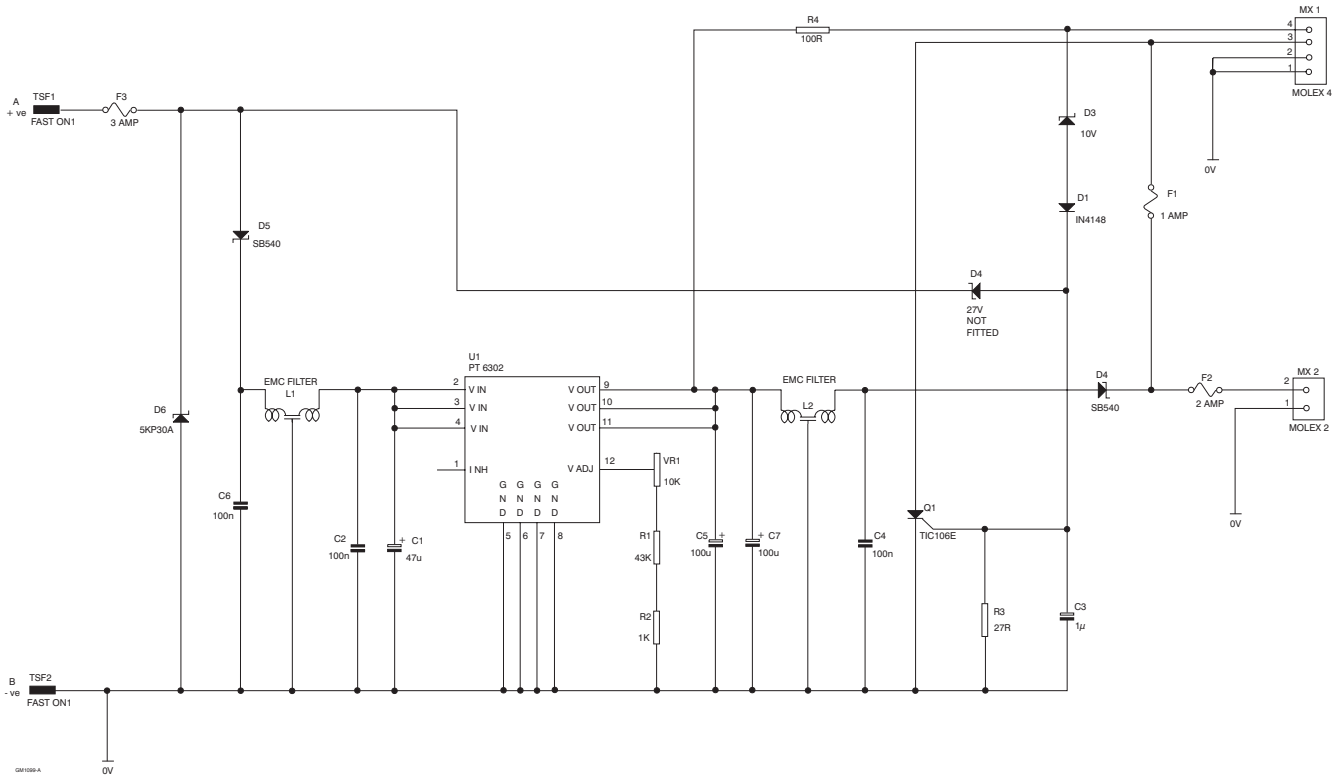


Figure 9.2 Power supply circuit diagram

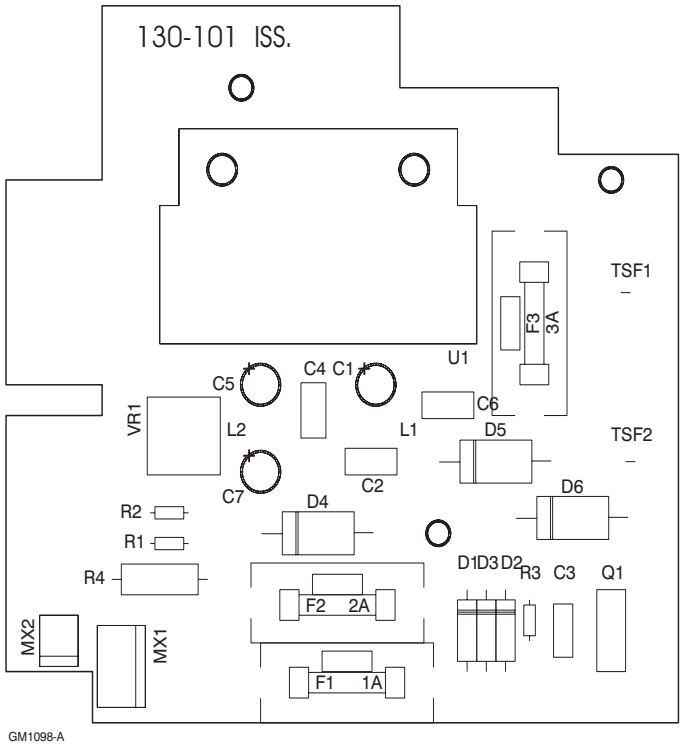


Figure 9.3 Layout of components on the power supply board

APPENDIX

FITTING a MODIFIED SIZE SENSOR FLAG

3200
In-line Pressure Syringe Pump

APPENDIX

FITTING a MODIFIED SIZE SENSOR FLAG

Introduction

In a continual and ongoing programme of improvements to their 3000 range of syringe pumps, Smiths Medical engineers have introduced a modified Syringe Size Flag (SSF) *1* that allows the size sensor mechanism to be accurately aligned (see *Figure A)*.

On recently manufactured pumps, a new thicker size sensor opto moulding and two associated longer fixing screws have been introduced at the same time as the modified SSF, in order to make the alignment procedures easy.

This Appendix enables a qualified Technician to fit the new SSF; the associated SSF shim/s, the new thicker size sensor opto moulding (if required), and to complete the final test procedures.

The SSF and shims etc. required to modify a pump are supplied in kit form (*part number 0137-0025*). The spares kit includes:

- SSF, *part number 0132-0090* (see *Figure A.1*)
- 0.6 mm thick shim, *part number 0130-0107*
- 1.0 mm thick shim, *part number 0130-0108*
- 1.2 mm thick shim, *part number 0130-0190*
- 1.4 mm thick shim, *part number 0130-0185*
- Opto housing, *part number 0130-0024* (4.65 mm thick)
- Screw, no. 4 x 5/8 inch, pozi, self-tap, *part number 5017-3410* (2 off)
- Grub screw, M4 x 6 nylon, *part number 0131-0144*
- Tamper proof protective cap, *part number 0131-0136*
- Instruction leaflet, *part number 0131-0217.*

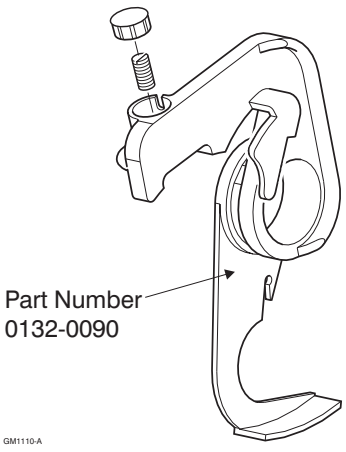


Figure A.1 New modified Syringe Size Sensor flag

WARNINGS

When a new SSF has been fitted to a pump, the pump must be tested using the Syringe Size Sensor gauges (*part number 0131- 0202*) available from Smiths Medical. Page A-3 gives details of the Final Testing procedures.

Ensure that the AC mains supply is switched off and the pump's AC connector is removed before opening the case halves.

CAUTION

During the removal and replacement of a pump's components, strict observance to Electro Static Discharge (ESD) rules must be observed at all times i.e. an earthing strap must be worn. Failure to apply ESD protection may result in damage to the pump, resulting in its malfunction.

The screws, washers and associated items that are removed during the disassembly of the pump are required during the reassembly.

Opening the case

1. Using a scratch free flat surface, turn the pump over to gain access to the base of the pump.
2. Undo the six screws holding the pump case halves together.
3. Place the pump upright and from the top carefully ease the halves apart, taking care not to put any strain on the internal connecting cable looms that form a hinge between the case halves.

Removal of old SSF

1. With the pump case open as detailed above, remove and retain the screw from beneath the umbilical board and displace the board in order to reveal the half-nut.
2. Disconnect the long thin spiral spring from its slot in the SSF, and pull out and remove the half-nut connecting pin.
3. Observing the position of the SSF in the rear of the case, and the position of the half-nut on the end of the large diameter support tube, lift the SSF and support tubes assembly up and away from the pump.
4. Remove the large half-nut screw, prise the half-nut apart and remove it from the support tube.
5. Slide the old replaceable SSF to the left, over and away from the small diameter support tube.
6. Remove connector PL1 from the size sensor opto moulding and also remove the two screws that hold the moulding in place.

Note:
The thickness of the size sensor opto moulding should be 4.65 mm (a new moulding and longer fixing screws are supplied in the SSF kit). If an old type moulding is fitted, i.e. 3.00 mm thick, it may be difficult to obtain the correct syringe size sensor results when the new SSF is fitted. If difficulty is experienced, contact your local representative or Smiths Medical, Service Department.

Reassembly

Remove any shim/s that were attached to the size sensor opto moulding. If required clean the shim area with a suitable solvent. The shim sizes provided in the kit are **0.6, 1.0, 1.2** and **1.4 mm.** If necessary, use a combination of shims to obtain the thickness required, up to a maximum of 2.4 mm. During production at Smiths Medical, a 1.6 mm shim is initially fitted to the pump.

Using the modified SSF, reassemble in reverse order to that given in steps (1) to (6) above, all the components that were disassembled.

Taking care not to trap any leads, assemble the casing ensuring that the case halves have snapped together and that the front and rear mating edges are equal and parallel. The six case screws should be tightened to a torque of between 70 and 75 cNm in the order shown in *Figure A.2*.

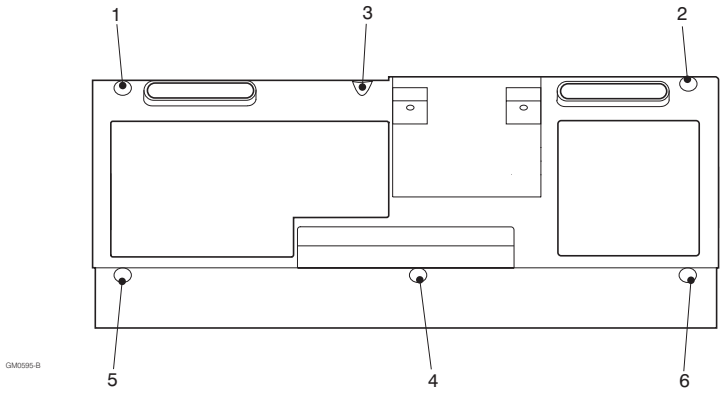


Figure A.2 Order for tightening the case screws

Final assembly

When a new SSF has been fitted, the pump must be subjected to the appropriate Functional Test procedures given in the associated Service Manual.

Before carrying out the syringe size sensor tests, ensure that the pole clamp has been correctly fitted and the six case securing screws have been tightened to a torque of between 70 and 75 cNm (see *Figure A.2*).

The Syringe Size Sensor tests are performed with the pump's plunger clamp at each of the two following positions:

1. 40 mm from the right-hand-side of the plunger clamp travel, and
2. at the extreme left-hand-side of the plunger clamp travel.

Also, the pump must be Configured during the tests to operate with the 'BD Plastipak' syringe.

Table A.1 on page A-5 lists the gauges that must be sequentially loaded onto the pump in order to verify that the Syringe Size Sensor mechanism is operating correctly.

The small adjustment grub screw in the SSF must be correctly set (see page A-4) before carrying out the Syringe Size Sensor tests. The small anti-tampering cap above the grub screw must then be fixed into place using a minimal amount of Loctite 414.

Setting the size sensor flag

1. Using the 3200 size sensor test gauges (see page A-5), fit the white 20 ml minimum sensor gauge (*part number 0131-0170*) into pump's cradle and observe whether (a) or (b) occurs:

a. If the pump indicates that a 20 ml gauge is fitted, complete steps (2) to (5).

b. If no indications are given, complete steps (6) to (8).

2. Depending upon the type of pump being set-up, if either the **20ml** LED is illuminated, or the display shows **20**, rotate the grub screw counter-clockwise until the corresponding LED/ display is extinguished or disappears.

3. Turn the grub screw slowly clockwise until the LED/ display illuminates or appears, indicating that a 20 ml syringe is fitted.

4. At position X (see *Figure A.3 Size Sensor Flag, general details*), alternately press and release the SSF several times and ensure that when the SSF returns to it's rest position, it ***always*** displays that a 20 ml syringe is present.

Note: It is acceptable that while the SSF is under force, the size of the syringe displayed alters. However, it must always return to the original 20 ml size displayed when the force is released.

5. If the pump does toggle between different syringe sizes, turn the grub screw *very* slightly clockwise and complete step (4) again until the 20ml LED/ display is stable.

Procedures if (b) above occurs

6. Depending upon the type of pump being set-up, if the **20 ml** LED is **not** illuminated, or the display does **not** show **20**, rotate the grub screw slowly clockwise until the LED/ display illuminates or appears indicating that a 20 ml syringe is fitted.

7. At position X (see *Figure A.3 Size Sensor Flag, general details*), alternately press and release the SSF several times and ensure that when the SSF returns to it's rest position, it ***always*** displays that a 20 ml syringe is present.

Note: It is acceptable that while the SSF is under force, the size of the syringe displayed alters. However, it must always return to the original 20ml size displayed when the force is released.

8. If the pump does toggle between different syringe sizes, turn the grub screw *very* slightly clockwise and repeat step (7) until the 20 ml LED/ display is stable.

   Apply a small amount of Loctite 414 to the anti-tampering grub screw cap and fit it.

   When the grub screw in the SSF has been set, the remaining procedures required to complete the size sensor testing may be completed. Press and release the SSF each time a new gauge is placed in the pump's cradle.

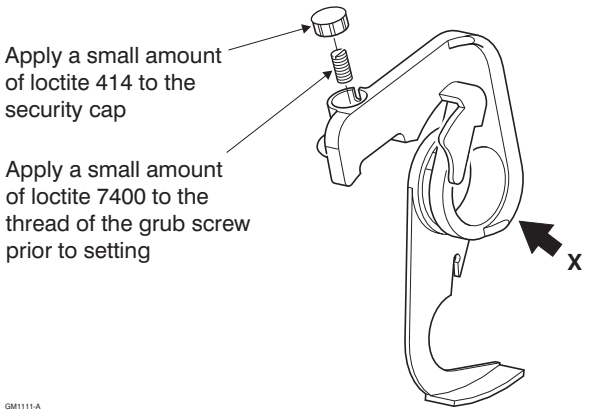

Apply a small amount of loctite 414 to the security cap
Apply a small amount of loctite 7400 to the thread of the grub screw prior to setting
X
GM1111-A

Figure A.3 Size Sensor Flag: general details

The Size Sensor Gauge set (*part number 0131-0202*) contains the gauges that are used to carry out the Size Sensor tests. These gauges are listed in *Table A.1*.

Table A.1 3200 Syringe Size Sensor Gauges (white)

PART No.	GAUGE DIA. (mm)	CORRECT RESULT	
0131-0165	11.20		No LED lit
0131-0166	12.50 - min.	**5ml**	LED lights
0131-0167	15.00 - max.	**5ml**	LED lights
0131-0168	16.20 - min.	**10ml**	LED lights
0131-0169	18.20 - max.	**10ml**	LED lights
0131-0170	21.00 - min.	**20ml**	LED lights
0131-0171	23.00 - max.	**20ml**	LED lights
0131-0172	23.70 - min.	**30ml**	LED lights
0131-0173	26.80 - max.	**30ml**	LED lights
0131-0174	29.00 - min.	**50/60ml**	LED lights
0131-0175	33.10 - max.	**50/60ml**	LED lights

The details given in this Manual are correct at the time of going to press. The company, however, reserves the right to improve the equipment shown.

For further information, please contact your local distributor or Smiths Medical direct on +44 (0)1923 246434

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